AD-A150 416 USER DATA PACKAGE SHORE-TO-SHIP ELECTRICAL POWER CABLE HANDLING EQUIPMENT(U) NAVAL CIVIL ENGINEERING LAB PORT HUENEME CA D E DAHLE JAN 85 NCEL-TN-1718 1/2

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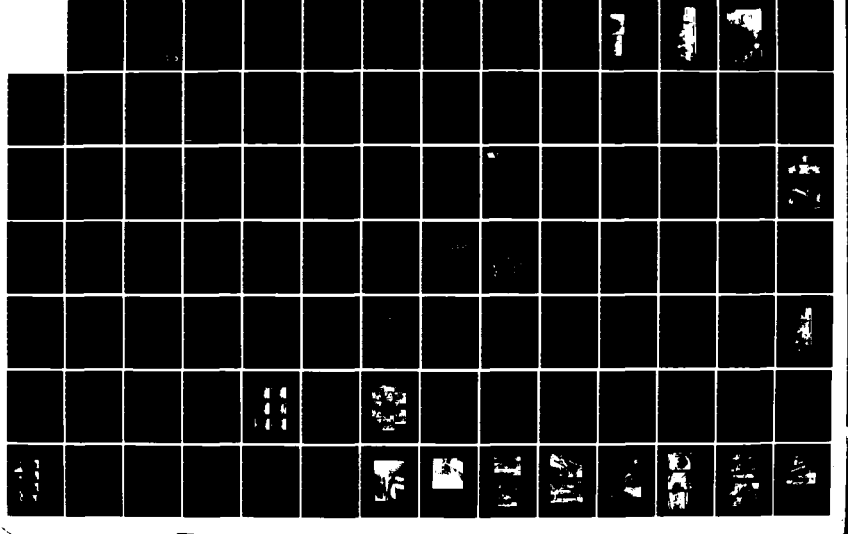

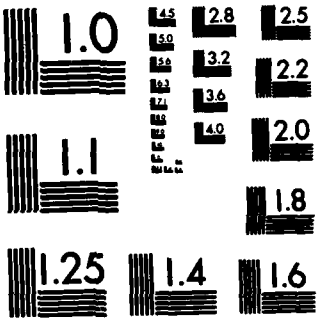

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

(12)

TECHNICAL NOTE

TN NO: N-1718

TITLE: USER DATA PACKAGE – SHORE-TO-SHIP ELECTRICAL POWER CABLE HANDLING EQUIPMENT

AD-A150 416

AUTHOR: D. E. Dahle

DATE: January 1985

SPONSOR: Naval Facilities Engineering Command

PROGRAM NO: YO995-01-002-063

NAVAL CIVIL ENGINEERING LABORATORY
PORT HUENEME, CALIFORNIA 93043

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METRIC CONVERSION FACTORS

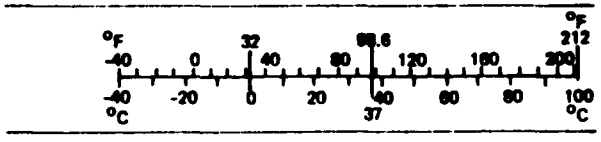
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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4 TITLE (and Subtitle) USER DATA PACKAGE – SHORE-TO-SHIP ELECTRICAL POWER CABLE HANDLING EQUIPMENT		5 TYPE OF REPORT & PERIOD COVERED Final; Oct 81 – Sep 83 6 PERFORMING ORG. REPORT NUMBER
7 AUTHOR(s) D. E. Dahle		8 CONTRACT OR GRANT NUMBER(s)
9 PERFORMING ORGANIZATION NAME AND ADDRESS NAVAL CIVIL ENGINEERING LABORATORY Port Hueneme, California 93043		10 PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 63725N; YO995-01-002-063
11 CONTROLLING OFFICE NAME AND ADDRESS Naval Facilities Engineering Command Alexandria, Virginia 22332		12 REPORT DATE January 1985 13 NUMBER OF PAGES 182
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from back p.

19 KEY WORDS (Continue on reverse side if necessary and identify by block number)

User data package, cable handling, shore power cable FLOW CHARTING, LOGISTICS SUPPORT, INSTRUCTION MANUALS,

20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

jump 1 → A User Data Package (UDP) was developed to provide information for transition of an R&D product into the NAVFAC acquisition system. The UDP addresses information to support system acquisition of shore-to-ship cable handling equipment developed and field tested by NCEL. The cable handling equipment demonstrated significant benefits to the Navy by reducing the time, manpower, and cable replacement costs associated with current → over

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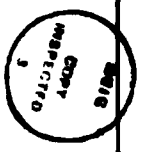
20. Continued

Public Works cable handling operations to provide shore electrical power to berthed Navy vessels. Originator-supplied key words include: → & cont'p.



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TN-1718 182 pp illus January 1985 Unclassified

1. Cable handling 2. Shore power cable I. YO995-01-002-063

A User Data Package (UDP) was developed to provide information for transition of an R&D product into the NAVFAC acquisition system. The UDP addresses information to support system acquisition of shore-to-ship cable handling equipment developed and field tested by NCEL. The cable handling equipment demonstrated significant benefits to the Navy by reducing the time, manpower, and cable replacement costs associated with current Public Works cable handling operations to provide shore electrical power to berthed Navy vessels.

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CONTENTS

Page

1.0 GENERAL PRODUCT DESCRIPTION

1.1 Current Methods

When Navy ships are in port, current policy encourages Cold Iron procedures (secure engineering plants) to conserve fuel and reduce ship's systems maintenance and repair. In order to go Cold Iron ships must be provided electrical power by the shore facility's Public Works activity.

The Public Works waterfront utilities support function is responsible for providing, storing, transporting, maintaining, and repairing the shore power cables used to provide electrical power to berthed Navy ships. Also, Public Works is responsible for all cable connections on the pier between the ship and shore electrical power source. Ships' personnel are responsible for rigging or unrigging cables between the pier and the ship and all cable connections aboard ship. → G-1473

There is a wide disparity in the methods and equipment used for handling and storing shore-to-ship electrical power cables at different Navy bases. At some facilities, cables are coiled on pallets and stored indoors or outdoors; at some, they are rolled on reels and stored indoors or outdoors, while another method includes flaking cables on wooden platforms located outdoors near the piers. At most activities cables are dragged and laid out along the pier edge by vehicles or manual methods (ship's working party) where they are subject to damage by vehicles, cargo equipment, or heavy objects either while in use or between ship service connections. For rigging cables aboard ship, a ships' working party (10-60 personnel) generally uses ropes to haul cables up to the ship's shore power station, with the exception of heavy lift crane service authorized for cable placement on high freeboard surface combatants like the Spruance Class destroyer. Manual rigging methods subjects the cable to damage as they are hauled over sharp deck edge coamings and obstructions and significantly increases personnel safety hazards.

The primary reason such methods are being used in handling THOF-500, three-conductor cables is that they are extremely heavy (approximately 8 lb/ft). Handling methods are largely manual, and as a result, require inordinate amounts of time and manpower, with the associated excessive requirements for maintenance, repair, and replacement costs for cables. Additional costs to the Navy include reduced Fleet readiness and degraded morale of ships' engineering and duty personnel.

1.2 New Methods and Equipment Description

The Naval Civil Engineering Laboratory (NCEL) recently completed development testing of prototype shore-to-ship cable handling equipment. The principal component of the prototype system consists of a commercially

available, hydraulic, telescoping boom mounted on a conventional stake truck, modified with special attachments for the application. The most significant feature is a hydraulic-powered rubberized block attached to the boom loadline which allows one operator and one or two helpers to pickup, elevate, payout, retract, and lower cable effortlessly and efficiently. The equipment has been designed to be operated by Public Works waterfront utilities personnel with proper training and licensing.

The primary functions of the cable handling boom truck are:

(1) Cable installation to/removal from berthed vessels (both pierside and nested ships)

(2) Cable layout/installation prior to ship arrival on piers

(3) Cable removal from piers after ship departure for maintenance and storage

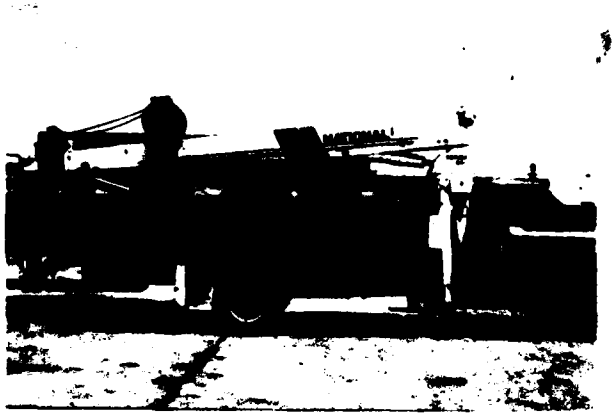
(4) Cable transport between storage facilities and piers

The recommended storage technique to maximize the utility of the cable handling equipment is to coil cables on minimum 4 ft by 4 ft standard wooden pallets. The hydraulic-powered block provides the capability to coil cables using three personnel. The cable palletizing technique minimizes support equipment (requires only a 6,000 lb forklift) and cable storage area requirements.

1.3 Summary of Test Results

A Fleet demonstration test was conducted at Naval Station Norfolk from May through July 1983. The prototype equipment installed and operated by Public Works Center Norfolk personnel confirmed significant benefits of the system to the Navy, identified in preliminary testing. These benefits include:

- average 40% reduction in time for rigging cables to pierside ships (average 55% time reduction for nested ships)
- average over 60% reduction in Fleet manhours required to rig cables (Navy wide benefit estimated at 120-130,000 manhour savings/yr)
- estimated potential of 25-30% increase in cable life (Navy wide benefit of at least $400,000/yr in cable replacement cost savings)
- improved appearance of piers due to timely removal of cables from piers after ship departure
- significant reduction in personnel (Fleet and PW) safety hazards
- overall improved Public Works responsiveness to Fleet readiness needs
- improved morale of Fleet personnel



Cable handling equipment w/palletized cables
(Modified commercial boom truck)

Equipment servicing 2 CGN-38 class cruisers returning
from Mediterranean deployment

OPERATION DEMONSTRATION TEST — NORFOLK (FY83)

RESULTS

- **Reduction in cable rigging/unrigging time — 40%**
- **Reduction in sailor manhours to rig/unrig cables — 60%**
  (Navywide benefit — Pierside/nested ships 130,000 MHRS/YR)
- **Reduction in cable replacement costs — 25-30%**
  (Navywide benefit estimated $400,000/Yr (min.))
- **Reduced safety hazards to fleet and shore personnel**
- **Improved appearance of piers from timely removal of cables**
- **Improve Public Works responsiveness to fleet readiness needs**

Figure 1-1. Shore-to ship cable handling equipment.

Figure 1-2. Shore power cable handling boom truck.

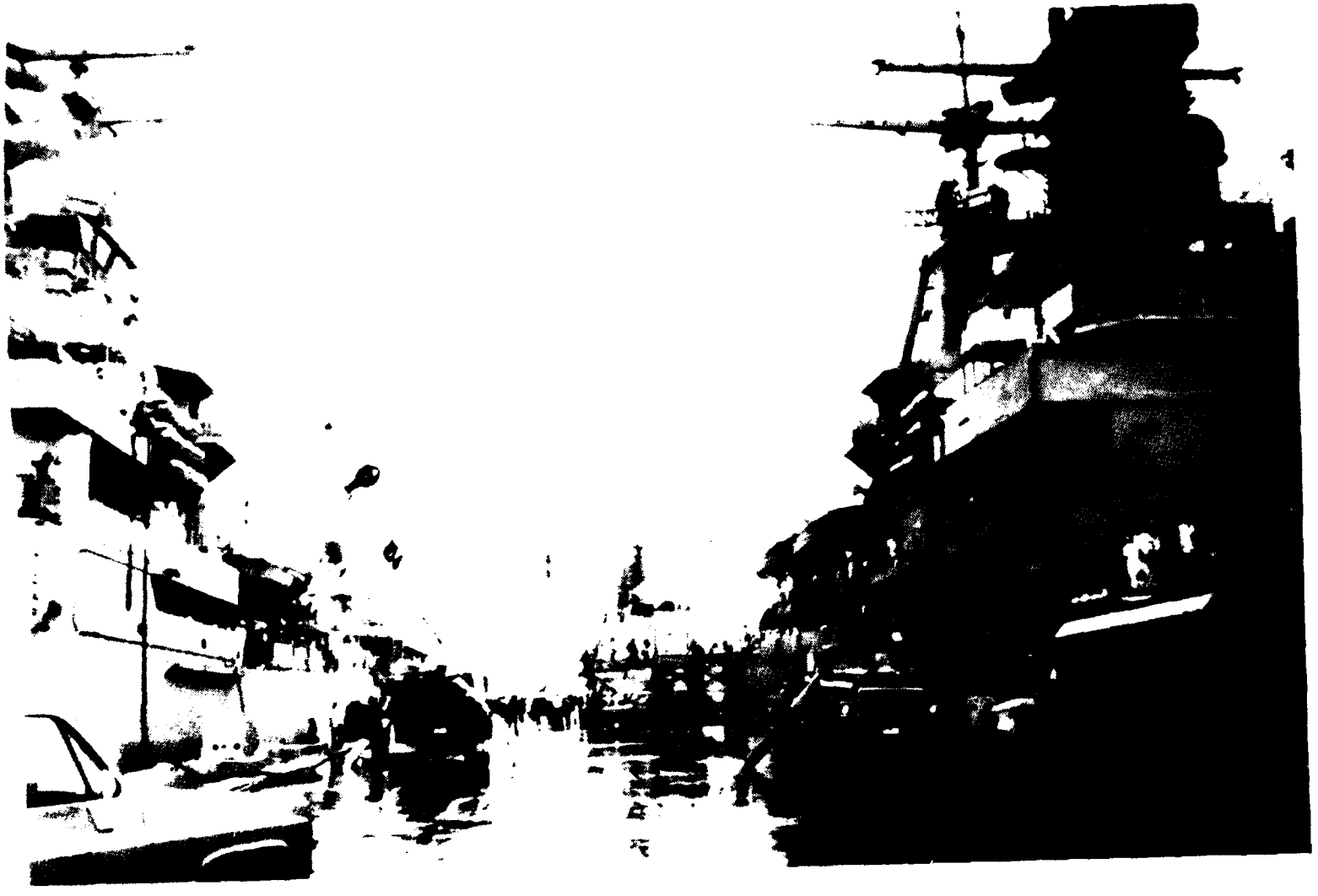


Figure 1-3. Shore power cable handling equipment providing electrical connect service to 2 CGN-38 class nuclear cruisers returning from Mediterranean deployment.

2.0 ACQUISITION FLOW CHARTS

2.1 User Data Package Inputs to Acquisition Flow Charts

The User Data Package (UDP) has been developed to provide a smooth transition of an R&D product into the NAVFAC system. Specific data and information provided in the UDP fall into the following categories:

- Planning (Section 3.0)
- Design (Section 4.0)
- Specifications (Section 5.0)
- Construction/Production (Section 6.0)
- Maintenance/Operations (Section 7.0)

Acquisition flow charts (Figures 2-1 and 2-2) provide a pictorial description of the process for implementing cable handling equipment. Public Works activities are the principal users of the cable handling system and, therefore, user level data and information have been developed for activity input at key decision and action stages during system implementation. In addition, data and information are provided for Engineering Field Divisions (EFDs) and NAVFAC Headquarters, whose management responsibilities are affected by introduction of new equipment (i.e., Civil Engineering Support Equipment (CESE) management).

Figure 2-1 is a simplified flow chart that indicates major milestones of cable handling equipment implementation.

Figure 2-2 shows the same implementation process with much greater detail to provide a comprehensive understanding of command relationships and who will provide decisions or information and take action to successfully implement cable handling equipment.

On both flow charts, User Data Package (UDP) inputs provide a reference to where information is found in the UDP text and are identified with the circled letters UDP.

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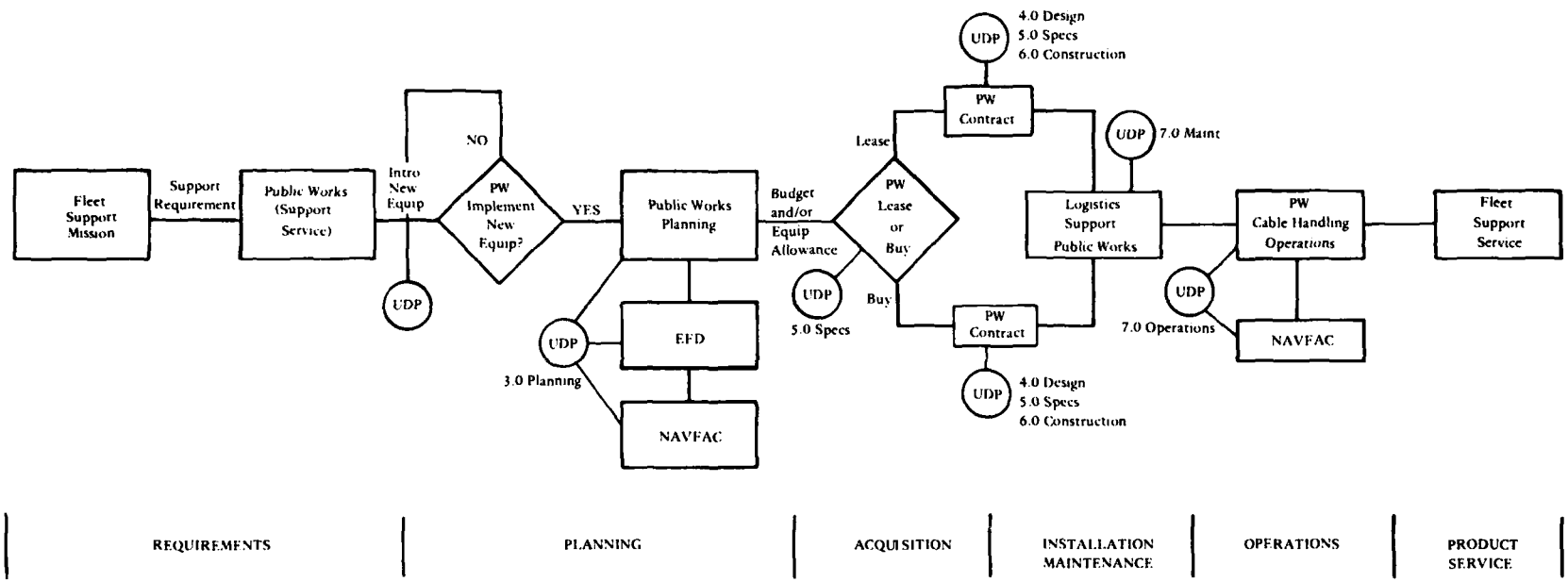
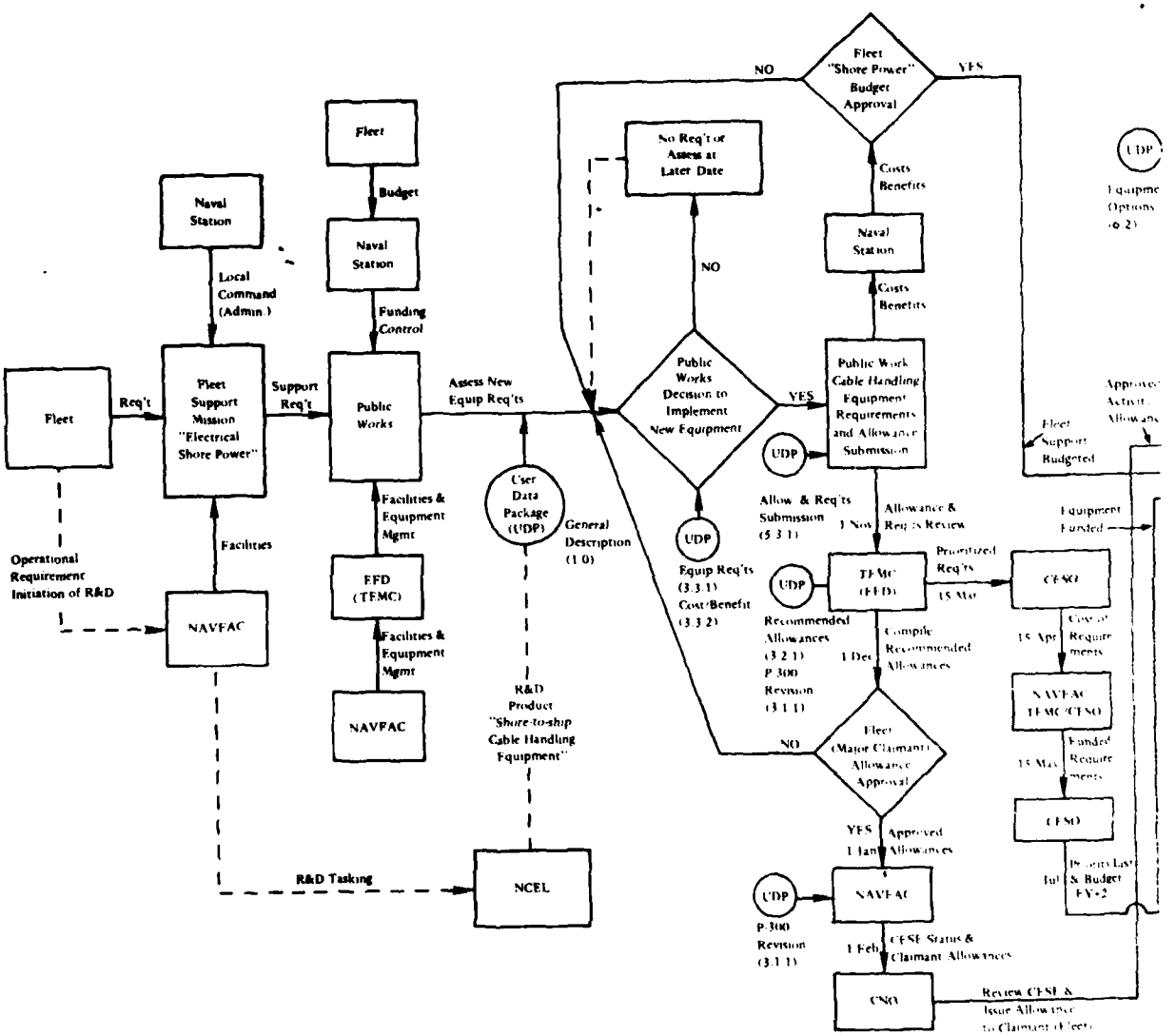


Figure 2-1. Acquisition Flow Chart - simplified



Requirement	Organizational Relationship	Planning

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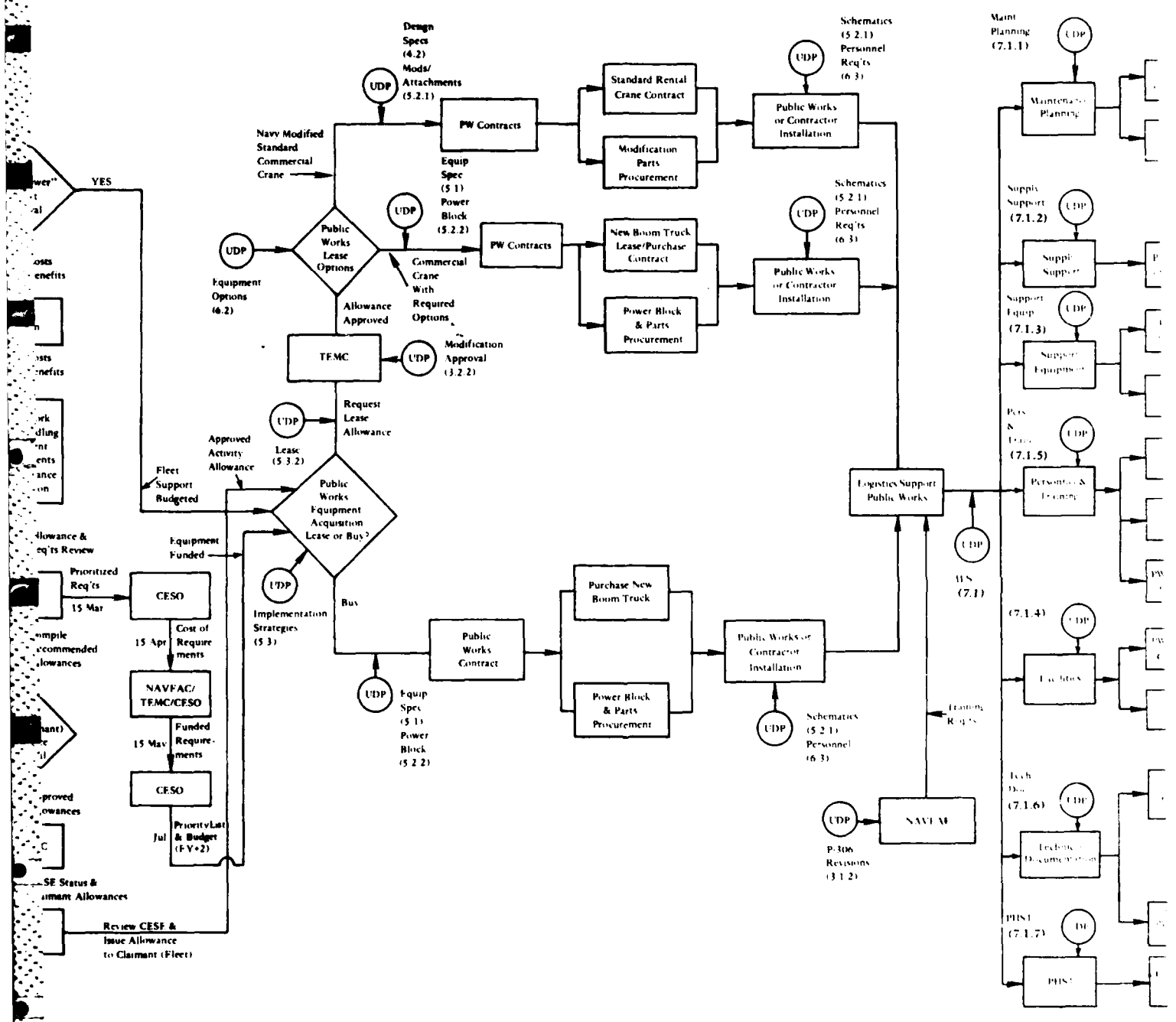

Acquisition

Figure 2-2. Acquisition Flow Chart - Activity Level - detailed

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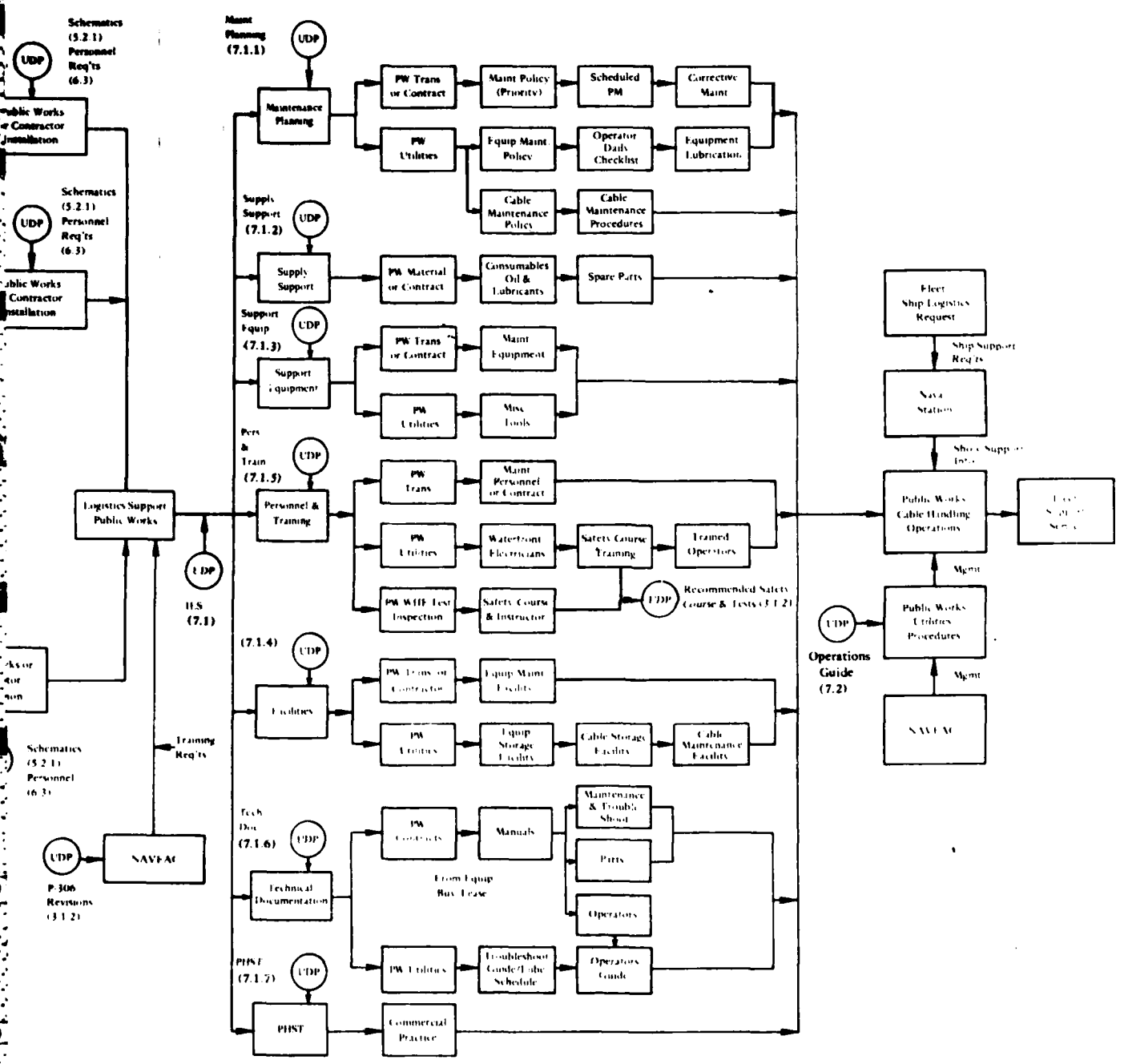

REPRODUCED AT GOVERNMENT EXPENSE

3.0 ACQUISITION PLANNING DATA

3.1 Naval Facilities Engineering Command (NAVFAC)

3.1.1 NAVFAC P-300 Revisions.

3.1.1.1 Appendix C.

pg C-5

change: 0735 truck, reel handling/tensioning, powered 02 12 300,000

to read: 0735 truck, cable handling, hydraulic boom 02 10 100,000

3.1.1.2 Appendix D.

pg D-7

insert: 0735-01 22/ Truck, Cable Handling, hydraulic boom, DED, 4x2/6x4, pwr steering, auto trans, w/3 section hydraulic telescoping boom, 64' height, 54' reach, minimum 10 ton capacity, 360° non-continuous rotation, hydraulic tool circuit for hydraulic pwrd block, with 16' wood floored stake body 39,000 10,000

pg D-15

add: 22/ Truck, Cable Handling, Hydraulic Boom. The truck is a 4x2 or 6x4 diesel engine driven truck cab and chassis with a minimum gross vehicle weight rating of 39,000 pounds with a 16' wood floored stake body platform. A three section, fully hydraulic, telescopic boom is mounted behind the cab, forward of the body with minimum 10 ton capacity at minimum reach and minimum 1,000 lb at maximum reach over 360 degree working area. Boom height is minimum 64 feet from ground to boom tip and minimum 54 foot reach w/2 sets of outriggers. A hydraulic tool circuit is installed (1,500 psi, 15 GPM capacity) with two 1/2-inch-ID hoses on spring retract hose reel for hydraulic power block attached to loadline. Mounted boom dual operator stations and (optional) remote control capability. The truck is intended for use in handling THOF-500 shore power cables

for cable connections to Navy ships at waterfront activities. 10,000 payload is for transporting cables between piers and storage facilities.

3.1.1.3 Appendix G.

pg G-5

change: 0735 O TRK REEL PWRD TRUCK, REEL HANDLING/ TENSIONING POWERED

to read: 0735 O TRK CABLE BOOM TRUCK, CABLE HANDLING, HYDRAULIC BOOM 39,000

3.1.1.4 Appendix H.

pg H-5

change: 0735 O 48 - - X

to read: 0735 O 100 - - X

Maintenance Manhour Input derivation:

Truck use - 1,560 hr/yr and 7,000 mi/yr[1]
Crane use - 33% of truck hrs = 546 hr
Maintenance for stake truck (est):
7,000 mi/yr x 9.2 MMH/1,000 mi^2 = 65 MMH/yr
Maintenance for crane (est):
1,520 oper hr (OH)/yr x .064 MMH/OH^3 = 35 MMH/yr
100 MMH/yr

3.1.1.5 References.

1. NCEL Port Hueneme - test data from demonstration test of cable handling equipment at NAVSTA Norfolk - FY83.

2. NAVFAC P-300 - Maintenance manhour input for stake trucks - Appendix H.

3. Reliability, availability, maintainability, and logistics engineering assessment of ship-to-shore electrical power cable elevation unit, Naval Civil Engineering Laboratory, Contract Report. Oxnard, Calif., VSE Corporation, Sep 1983.

3.1.2 NAVFAC P-306 Revisions.

3.1.2.1 No text revisions required.

3.1.2.2 Recommended Safety Course Outline.

In accordance with Chapter 4 paragraph 4.1.4 the crane safety course outline may be altered or tailored for types of boom truck. Personnel planned for use of this equipment are not intended to be general crane operators and will only be used for cable handling operations consistent with the intended equipment design.

The following is a suggested course outline for the cable handling boom truck, ECC 0735:

First day

2 hrs a. General description of cable handling boom truck

(1) Size and characteristics of machine
(2) Various operating modes, i.e., hoisting, telescoping, swing, and power block
(3) Major components of hoist, telescope, swing, and power block functions
(4) Define load bearing, load controlling components and safety devices

1 hr b. General safety

(1) Major cause of mishaps and cite examples.
(2) Maintaining machine in satisfactory working condition.
(3) Results of unsafe operations.
(4) Describe ways to avoid accidents.

1 hr c. Operator's physical, emotional, and mental condition

(1) Operator determination of personal, physical, mental, and emotional condition.
(2) Alert requirement.
(3) Side effects of medication.
(4) Operator responsibility for safe operation.
(5) See supervisor if in doubt.

1 hr d. Understanding the equipment

(1) Read/understand manufacturer's operator manual.
(2) Read/understand posted instructions.
(3) Understanding activity safety instructions.
(4) Conflicts with instructions.

1/2 hr e. Operator's daily checklist (ODCL)

(1) Purpose of daily inspection.
(2) Inspect items on ODCL.
(3) Completing ODC.
(4) Turn in completed ODC.

1-1/2 hr f. Instruction for conducting operator's daily inspection

(1) Purpose of daily inspection.
(2) How daily inspection is conducted.
(3) Parts of daily inspection.
(4) Walk around inspection.

(a) Walk around insepction.
(b) Observe and report conditions on applicable items on ODCL.

(5) Operating inspection

(a) Engine running.
(b) Alert personnel prior to operation.
(c) Operate through various modes and perform inspection of applicable items on ODCL.
(d) Observe and report conditions on applicable items on ODCL.

(6) Unsafe conditions

(a) Determining unsafe conditions.
(b) Major deficiency of load bearing, load con parts of safety devices.
(c) Reporting conditions of unsafe cranes.

1 hr g. Review, quiz, discussion covering first day material

Second day

1-1/2 hr a. Load rating charts

(1) Safe handling of load using load rating chart.
(2) Weight of load.
(3) Boom configuration and length.
(4) Ground condition.

(a) Level machine.
(b) Outrigge.s/no tire stability.

(5) Work quadrant operation.
(6) Use of indicating devices.
(7) Define stability and structural competence.
(8) Manufacturer's notes used with load rating chart.
(9) Derating load chart due to attachments (i.e., powerblock).
(10) Sample problems using simple and complicated load rating charts.

1 hr — b. Standard hand signals (adopted for this application).

(1) Using approved hand signals--Figure 4 (P-306).
(2) Purpose of using hand signals.
(3) Receiving correct signal prior to moving machine.
(4) Designated signal person.
(5) Exception to designated signal person.

1 hr — c. Position for stability

(1) Prevent overturning.
(2) Firm ground support.
(3) Setting outriggers correctly.
(4) Determine operating radius.
(5) Use load rating charts.
(6) Location of load in quadrant of operation.

1/2 hr — d. General precautions

(1) Awareness of surroundings.
(2) Operating around people and obstructions.
(3) Speed and effort of operation.

1/2 hr — e. Electrical power lines

(1) De-energize power lines/ships antennas.
(2) Minimum working distance from energized power lines.
(3) Leaving an electrified crane.

1/2 hr — f. Positioning the boom

(1) Location of load.
(2) Side loading boom.
(3) Effects of simultaneously lowering boom and hoist line under load.

1/2 hr g. Hoisting/lowering the load

(1) Using load rating chart.
(2) Received proper signal.
(3) Sequence of checking load brakes.
(4) Failure of load holding brakes during lifts.
(5) Minimum number of wire rope wraps on drum.

1/2 hr h. Rotating the load

(1) Clearing all obstructions.
(2) Checking swing motion control/holding valves.
(3) Failure of swing motion control/holding valves during swing operation.

1/2 hr i. Securing equipment

(1) Consult manufacturer's instruction manual.
(2) Truck shutdown procedure.

(a) Position boom.
(b) Secure hook and block.
(c) Disengage PTO.
(d) Complete ODCL.

1 hr j. Review of course

1/2 hr k. Test covering course material

3.1.2.3 Recommended Performance Test. After applicant has successfully passed exam covering safety course material, applicant shall be given a performance test to include as a minimum:

a. Handling a freely suspended load (load weight shall be based on instructor's recommenations and expected working radius) to demonstrate clear understanding of crane safety procedures and ability to perform smooth, controlled operating functions.

b. Handling of minimum 125 ft lengths of THOF-500 cable including hoist, swing, payout/retract, lower, etc., to demonstrate ability to control cable load and avoid side loading.

Applicant shall be licensed only when enough training (particularly hands on operating) has been provided to meet instructor's requirements for safe cable handling operations in the operating environment of piers around ships and personnel.

3.1.2.4 Licensing and Records. Licensing and Records shall be kept in accordance with NAVFAC P-306 guidance.

a. Recommended equipment data description for equipment operator's application (NAVFAC Form 11260/1), License (NAVFAC Form 11260/2) and record (NAVFAC Form 11260/3):

Equipment Type:	Cable Handling Boom Truck
Size and Capacity:	10 ton (Note single part line only to be used; therefore, maximum lift cannot exceed 2-1/2 ton)
Type of Controls:	Hydraulic
Attachments:	Hook, hydraulic powered block

3.1.2.5 Operator Requirements. Cable handling equipment operator should be a journeyman electrician WG-7 or higher grade based on recommendations by PWC Norfolk, Civilian Personnel Department.

3.2 Transportation Equipment Management Centers (TEMC)

3.2.1 Allowance Requirements - Allowance Code 002G. (Recommendations based on *NCEL test data-Norfolk Fleet Demonstration Test* - FY83)

ECC 0735

	Allowance	Inventory
CINCLANTFLT		
PWC Norfolk	6*	2*
PWD Charleston	2	0
PWD Mayport	1-2	0
CINCPACFLT		
PWC San Diego	5**	1***
PWD Long Beach	1	0
PWC Pearl Harbor	1	0
PWC San Francisco	1	0
PWC Yokosuka	1	0
PWC Subic Bay or Guam	1	0

*Currently PWC Norfolk has 2 reel handling trucks with ECC 0735.
**One to NAS North Island.
***One cable handling boom truck at NAVSTA, SD (procured under Fast Payback - FY82).

3.2.2 Modification Approval Issue. In accordance with NAVFAC P-300, Chapter 24, paragraph 24-2, "All alterations or modifications...to weight handling equipment...shall be approved by the cognizant EFD." In response to this requirement NCEL has contacted manufacturers of equipment which fulfill design requirements of the cable handling boom truck. NCEL disclosed intended end use and required modifications to their standard commercial equipment. Manufacturers representatives indicated that all additional attachments required are offered as optional features with the exception of the hydraulic powered block and swivel assembly attached to the boom loadline. Their responses to NCEL's inquiries are attached as Exhibit A.

The optional features offered by the manufacturers have been incorporated into the purchase description (specification) for the cable handling boom truck (see Section 5.1). Therefore, no modifications will be required by activities which use the purchase description for equipment acquisition.

3.3 Activities

3.3.1 Equipment Requirements. The number of cable handling boom trucks required by a Public Works activity to provide improved shore electrical service to the Fleet is a function of several factors. These factors include:

- the average number of ship movements per week
- the daily distribution of ship movements during a typical week
- the percentage of ships which do not carry their own shore power cable (i.e., shore activity provides all cable, except ship's plug and pigtail)
- number or percentage of ships berthed in nested configurations
- peak load or maximum number of ship movements per week
- percentage of ships requiring longer than 125 ft cable lengths or ship's cable too short to reach pier receptacle
- and in certain cases the mix of homeported ships (ship classes and quantities) including visiting and transient ships

Each Public Works activity should examine historical data and any known future changes (i.e., ship homeport assignments) to address each of the above factors to develop cable handling equipment operational requirements. The requirements can then be matched to equipment operations data (Tables 3-1 and 3-2) to estimate equipment requirements.

Table 3-1 provides time and manpower requirements for rigging or unrigging cables between the pier and a ship. Data from operational tests in Norfolk were analyzed and adjusted to provide one table which reflects average requirements of all surface ships with the exception of

MSO, ARS, ASR, ATF, AGDS, AGF, and AGFF class ships. Table 3-1 is recommended for use by activities servicing several ship classes representing some mix of carriers, surface combatants, amphibious or auxiliary ships.

Table 3-2 provides time and manpower requirements for Public Works personnel to perform several functions associated with shore-to-ship electrical service. These functions include: cable transport, installation or removal on a pier, storage and inspection, and cable connections on the pier.

To illustrate the use of data in Tables 3-1 and 3-2, the following example provides a suggested format to assess activity specific cable handling equipment requirements.

Example: Cable Handling Equipment Requirements Assessment

Operational Requirements

Average number of ship movements/week: 10

Daily distribution of ship moves: (depart/arrive)	0/0 S	3/0 M	1/0 T	1/0 W	0/2 T	0/3 F	0/0 S

% of ships without ships' cable: 60%
% of ships requiring extra cable lengths for service: 70%
% of ship nested outboard: 20%
peak load ship moves/week: 18
types of inline connectors used: Camlock Quik Disconnect

To summarize the operational requirements data, during a typical week, the PWD will service 10 ships, 5 departures, 5 arrivals. Six of those 10 ships require(d) cables supplied by the PWD, 7 of 10 ships require(d) extra cable lengths laid out prior to ship arrival for electrical service, and 2 of the 10 ships are expected to be nested outboard.

Data from Tables 3-1 and 3-2 is used as follows to estimate equipment operating hours/week:

Equipment Requirements

(1) Cable rig/unrig - pierside .8 x 10 x 28.5 min x $\frac{\text{hr}}{60 \text{ min}}$ = 3.80 hr

(Table 3-1) - nested .2 x 10 x 52.6 min x $\frac{\text{hr}}{60 \text{ min}}$ = 1.75 hr

(2) Load/trans/layout cable .7 x 5 x 57 min x $\frac{\text{hr}}{60 \text{ min}}$ = 3.33 hr
(Table 3-2: 1, 2, 3)

(3) Load/trans cable for arriving ships (Table 3-2: 1, 2)

$$.6 \times 5 \times 24 \text{ min} \times \frac{\text{hr}}{60 \text{ min}} = 1.20 \text{ hr}$$

(4) Remove/trans/palletize cables (Table 3-2: 2, 4, 5)

$$.6 \times 5 + 7 \times 5 \times 82 \text{ min} \times \frac{\text{hr}}{60 \text{ min}} = 8.88 \text{ hr}$$

(5) Round trips to piers for cable rig/unrig (Table 3-2: 2)

$$10 \times 10 \text{ min} \times \frac{\text{hr}}{60 \text{ min}} = 1.67 \text{ hr}$$

(6) Equipment at pier during cable connections and disconnections (Table 3-2: 6a, 6b (avg.))

$$10 \times 24 \text{ min} \times \frac{\text{hr}}{60 \text{ min}} = 4.00 \text{ hr}$$

Weekly total = 24.63 hr

The example above certainly assumes ideal conditions where ship arrivals are spaced to allow hookup of one ship prior to next ship arrival, and ship scheduling has permitted Public Works to layout cables on piers prior to ship arrivals. Although ideal conditions rarely occur, the example illustrates a general relationship between equipment operating hours and mission requirements to support the Fleet. In this case one (1) cable handling boom truck is sufficient. The intent is to provide a means to assess equipment requirements to provide an appropriate level of utilization. During peak loads, as in the above example, equipment operating hours would likely exceed 40 operating hours per week. This could justify a second piece of equipment, however, the activity must examine the frequency and equipment needs of such peak loads and the associated low equipment utilization during off peak periods.

Special Considerations

Types of Ships Serviced. The data provided in Table 3-1 is a good approximation of cable rigging/unrigging time and manpower requirements, however, for DDG-2 Adams class destroyers (which usually carry ship's cable) the requirements will be quite high for this low freeboard ship and in contrast for carriers the requirements are quite low since at least 24 cables (at 3 or 4 shore power stations) are required versus the average 5.6 cables for all surface ships. Therefore, an activity servicing only auxiliaries (of which most carry ship's cable) and low freeboard destroyers will find the benefits of using the cable handling boom truck will be limited primarily to handling cables on piers. An activity which primarily services carriers might require more than one cable handling boom truck for the carriers multiple shore power stations, but low equipment utilization would result due to infrequent carrier movements.

Peak Loading of Ships. To examine the effect of peak loads (weekly or daily) on equipment requirements, data from Tables 3-1 and 3-2 should be used. As an example, if 10 ship arrivals between 1000 and 1700 on Friday afternoon are expected, use Table 3-1 data for connects only (pierside and nested ships as required) with cable loading, transport, and cable connection requirements from Table 3-2. By adding all the time requirements and dividing by the time available to do the work (1000 - 1700 = 7-8 hr), peak load equipment requirements can be determined. If peak load equipment requirements are significantly higher than those for a weekly average, then low equipment utilization will result. Each activity must determine tradeoffs between equipment utilization rates and peak load requirements to provide improved Fleet support at an acceptable cost.

Summary

In general, a good utilization rate for the cable handling equipment is 30 hours/week, or 1,560 hours per year. This allows for preventive maintenance and additional operational requirements that might arise. One cable handling boom truck for every 12 ship movements/week would provide adequate utilization. Use the form provided on page 26 to assess specific requirements for your activity.

3.3.2 Cost/Benefit Analysis. Electrical hookup/disconnect services for Fleet ships is authorized and budgeted by CINCLANTFLT or CINCPACFLT as the benefiting customer. In most cases, the Naval Station provides accounting and control of funds for reimbursement to Public Works activities for services rendered. Therefore, the cost/benefit analysis will be developed to assess costs and benefits attributed to CINCLANTFLT or CINCPACFLT from implementing shore power cable handling equipment.

3.3.2.1 Cost Factors. To implement the new cable handling system, equipment and personnel costs will be charged to the Fleet customer for improved service. These cost factors will be compared against current Fleet electrical hookup costs and weighed against Fleet received benefits.

1. Equipment Costs.

(a) Cable handling boom truck (assumes 1,560 operating hrs (OH)/yr)

Operating cost - $2.50/OH (fuel + oil) x 1,560 OH/yr	= $ 3,900/yr
Maintenance cost - 100 MMH x $30/MMH x 1.4 (material factor)	= 4,200/yr
Depreciation cost - $100K (capital cost)/10 yr (equipment life)	= 10,000/yr
	$18,100/yr

(b) Forklift (if currently not used)

PW Transportation rental rate (est) $400/mo x $\frac{12 \text{ mo}}{\text{yr}}$ = $4,800 yr

2. Personnel Costs.

(a) Additional personnel required to provide 3 personnel per cable handling unit.

Additional personnel cost (each person)

2,000 hr/yr x $25/hr (Utilities department labor rate) = $50,000/yr/man

3.3.2.2 Benefits. Principal benefits of the new cable handling equipment to the major claimant (CINCLANTFLT or CINCPACFLT) include reductions in both time and ships' force manhour requirements for rigging or unrigging shore power cables. Additional cost savings are anticipated from the potential to reduce cable wear and tear and associated cable replacement costs.

Further significant benefits, although less tangible include: improved morale of ships engineering/duty personnel; increased liberty mandays available to engineering/duty personnel; reduced safety hazards to Fleet and shore personnel when handling cable, improved appearance of piers due to timely removal of cables left on piers after ship departure; and improved responsiveness of Public Works to Fleet readiness needs.

To quantify time and manhour savings of ship's personnel, it is assumed that the cable handling equipment provides service to 90% of the ships in port and that 20% of those ships are nested. Using the data in Table 3-1 page 22, the time and manhour savings are as follows.

Time Savings (per movement - connect or disconnect)

Pierside ships - $\frac{\quad}{\text{moves/yr}} \times .9 \times .8 \times (53.2\text{-}28.5) \frac{\text{min}}{\text{move}} \times \frac{\text{hr}}{60 \text{ min}}$

+

Nested Ships - $\frac{\quad}{\text{moves/yr}} \times .9 \times .2 \times (113.1\text{-}52.6) \frac{\text{min}}{\text{move}} \times \frac{\text{hr}}{60 \text{ min}}$

(1) Total Time Savings/Yr = $\frac{\quad}{\text{moves/yr}} \times .478 \frac{\text{hr}}{\text{move}} = \frac{\text{hr}}{\text{yr}}$

Note: Time savings contributes to fewer steaming hours. Average Fleet fuel consumption while steaming and not underway is estimated at 6.8 barrels/hr (Reference 1) (does not include MSO, ASR, ARS, and other small ships) (Reference 1).

Fleet Manhour Savings (per movement - connect or disconnect)

Pierside ships - $\frac{\quad}{\text{moves/yr}} \times .9 \times .8 \times (10.75\text{-}2.96) \frac{\text{mhrs}}{\text{move}}$

+

Nested Ships - $\frac{\quad}{\text{moves/yr}} \times .9 \times .2 \times (48.44\text{-}16.63) \frac{\text{mhrs}}{\text{move}}$

(2) Total Manhour Savings/Yr = $\frac{\quad}{\text{moves/yr}} \times 11.33 \frac{\text{mhrs}}{\text{move}} = \_\_\_\_ \text{ mhrs/yr}$

Note: Average productive hourly wage for electricians EM1 and EM2 is $\$9/hr^2$.

Cable Replacement Savings. A 30% increase in cable life due to reduced wear and tear of current cable handling techniques is anticipated, which results in at least a 23% reduction in annual cable replacement costs.

(3) Cable Replacement Savings =

Average annual cable replacement cost x .23 = _____ $/yr

Use the cost benefit analysis form provided on pages 27 and 28 to assess Fleet benefits achieved for increased charges incurred.

3.3.2.3 References.

1. Ships steaming and fuel consumption data for FY80, David Taylor Naval Ship Research and Development Center. Bethesda, Md.

2. Data for enlisted billet cost model for FY83, Naval Personnel Research and Development Center. San Diego, Calif.

Table 3-1. Time and Manpower Requirements for Cable Rigging/Unrigging (Includes Equipment Setup to Last Cable Rigged/Unrigged)

	Connect	Disconnect	Average Movement
Pierside Ships			
Average time (minutes)			
w/ CHBT[a]	34.1	22.9	28.5
w/o CHBT	66.8	39.6	53.2
Public Works Manhours			
w/ CHBT	2.50	1.15	1.83
w/o CHBT	2.84	1.73	2.28
Fleet Manhours			
w/CHBT	3.52	2.40	2.96
w/o CHBT	14.90	6.61	10.75
Nested Ships			
Average Time (Minutes)			
w/CHBT	59.9	45.4	52.6
w/o CHBT	125.4	100.8	113.1
Public Works Manhours			
w/CHBT	3.63	2.28	2.96
w/o CHBT	4.74	4.19	4.47
Fleet Manhours			
w/CHBT	19.99	13.22	16.63
w/o CHBT	57.62	39.20	48.44

[a]CHBT - Cable Handling Boom Truck.

Table 3-2. Public Works Time and Manpower Requirements to Handle Shore Power Cable

	Setup	Min/Cable	Crewsize	6 Cable Total	
				Time	Man-hr
1. Load palletized cable at storage facility	5	1.5	3	14	.70
2. Transport cables to pier (round trip - 4 miles)	-	-	3	10	.50
3. Layout cables on pier	3	6	3	33	1.65
4. Remove cable from pier	3	4	3	27	1.35
5. Palletize and inspect cables at storage facility	3	7	3	45	2.25
6. a. Cable connections or disconnections - inline and viking pluts - (using inline quick connectors)	-	1	2-3	12	.4
b. Cable connections or disconnections - inline and viking plugs - (using inline bolt/lug and tape)	-	3	2-3	36	1.4

Cable Handling Equipment Requirements

Activity _____
Auth Sig _____
Date _____

Operational Factors

1. Average number of ship movements per week: ____
2. Daily distribution of ship in typical week: (depart/arrive) / S / M / T / W / T / F / S
3. % of ships without ship's cable: ____
4. % of ships requiring extra cable: ____
5. % of ships nested outboard: ____
6. Types of inline connectors used a) ____ Quick-Disc b) ____ bolt/lug
7. Peak load - number of ship movements per week: ____

Equipment Requirements - (assume equal number arrivals/departures)

8. Cable rig/unrig - pierside (1-(5)) x (1) x 28.5 min x $\frac{\text{hr}}{60 \text{ min}}$ = ____ hr

   nested (5) x (1) x 52.6 min x $\frac{\text{hr}}{60 \text{ min}}$ = ____ hr

9. Load/trans cables for arriving ships in (8) (3) x (1) x 24 min x $\frac{\text{hr}}{60 \text{ min}}$ = ____ hr
10. Load/transport/layout cables for arriving ships - extra lengths (4) x (1) x 57 min x $\frac{\text{hr}}{60 \text{ min}}$ = ____ hr
11. Remove/transport/palletize cables from departing ships (3) x (4) x (1) x 82 min x $\frac{\text{hr}}{60 \text{ min}}$ = ____ hr
12. Trips to/from piers for (11)/(8) (1) x 10 min x $\frac{\text{hr}}{60 \text{ min}}$ = ____ hr
13. Equipment at pier for connections

    6a (1) x 12 min x $\frac{\text{hr}}{60 \text{ min}}$ = ____ hr

    or

    6b (1) x 36 min x $\frac{\text{hr}}{60 \text{ min}}$ = ____ hr
14. Total Equipment Utilization (add 8 thru 13) ____ hr
15. Equipment Requirement (round up (14) ÷ 30 hr) ____ units

Cost/Benefit Analysis

ACTIVITY _____
AUTH SIG _____
DATE _____

Costs

1. Equipment Requirements

___ Cable handling boom truck(s) x 18,100 each = $ _____/yr
no.

___ Forklift (only 1 required) x $4,800 = $ _____/yr
no.

2. Personnel Requirements

___ Personnel x $50,000 each = $ _____/yr
no.

3. Cable handling system additional costs = $ _____/yr

4. Current annual CINCLANT/CINCPAC electrical hookup budget = $ _____/yr

5. % increase in current electrical hookup budget = _____ %
(3÷4x100)

Benefits

1. Time savings

_____ x .478 hours/movement = _____ hours/hr
ship movements/yr

_____ hr/yr x 6.8 bbl/hr fuel x $_____/bbl = $_____/yr

2. Manhour savings

_____ x 11.33 manhours/move = _____ manhours/yr
ship moves/yr

_____ manhour/yr x $9.00/manhour = $_____/yr

3. Cable replacement savings

_____ x .23 = $ _____/yr
cable replacement costs/yr-NAVSTA _____

4. Total Fleet savings = $ _____/yr

5. Additional benefits

- improved crew morale
- increased liberty available
- reduced safety hazards
- improved pier appearance
- improved PW responsiveness to Fleet

NATIONAL CRANE
Subsidiary of Kidde, Inc
KIDDE

General Offices 11200 North 148th Street / Waverly, NE 68462 / (402) 786-2240 / Telex 438061
Service Center 701 N.W. 27th Street / Lincoln, NE 68528 / (402) 474-2666

January 4, 1983

Mr. D. E. Dahle, M.E.
Military Projects Division
Department of the Navy
Naval Civil Engineering Laboratory
Port Hueneme, CA 93043

Dear Mr. Dahle:

After reviewing the information in your correspondence of December 27, 1983, I believe that National Crane can meet your requirements with an essentially stock unit. The National 656 has recently been updated and renamed the 656A, however, the performance characteristics and features will be the same or slightly improved from the unit which you tested. The control valves and hose reels that were added on the test unit are available from National Crane as an optional extra and should be a substantial cost reduction from the components listed in your memo, particularly if remote operation is not required. Since these components would be furnished by National Crane, the operational and safety features built into the system would not be compromised. In addition to the anti-two block option, I would also suggest the inclusion of a hydraulic capacity alert system to prevent inadvertent overloading of the crane (suggested retail price $995).

If you have any further questions, please do not hesitate to contact me.

Sincerely,

J. F. Orley

JFO/pat

cc: Jerry Dexter

Exhibit A

4.0 DESIGN DATA

4.1 Cable Handling Equipment Design Criteria

1. Minimum space required on pier.

2. Cable transport capability - 10-12,000 lb cable payload (1,250-1,500 ft at 8 lb/ft).

3. Provide mechanism to safely grip and support 3 inch OD three conductor electrical cable without damaging cable jacket or conductors. Include powered payout and retract capability.

4. Capability to layout 125 ft cable length along pier edge without moving equipment.

5. Be able to pick up 125 ft or longer cable lengths along pier edge without moving equipment.

6. Capability to elevate and payout cable aboard any Navy ship class.

7. Capability to retract and lower cable from any Navy ship class.

8. Require only one equipment operator.

9. Simple design for ease of maintenance and better reliability.

10. Maximize use of off-the-shelf components to reduce need for long lead items.

4.2 Truck and Crane Design Specifications

4.2.1 Truck. Diesel engine driven with vertical exhaust stack 4x2 or, 6x4, with automatic transmission.
Minimum GVW 39,000 lb
FAWR - 16,000 lb
RAWR - 23,000 lb
Heavy duty frame reinforcement
16 ft wood floored stake body w/step type rear bumper
PTO direct mount

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4.2.2 Hydraulic Boom.

Minimum reach capacity - minimum 10 ton
Maximum reach capacity - 1,000 lb-minimum
Vertical height - ground to sheave minimum 64 ft
Maximum reach - 54 ft
360° non-continuous full-rated capacity (360°)
3 section full hydraulic telescopic boom

4.2.3 Truck and Crane Accessories (Options).

Gages in lieu of indicators
Engine and hydraulic system hourmeters
Anti two block system
Remote control capability w/o remote control pendant
Night lights - 2 spots behind operator station
- 2 floods illuminating boom
Hydraulic tool circuit 1,500 psi, 15 GPM w/2 each, 50 ft 1/2-inch hoses on spring retract reels w/fairlead assembly at end of outer boom

4.2.4 Cable Handling/Attachments on Boom.

Hydraulic load bearing swivel
Power block - Marco Model 19B/919B w/power grip

4.3 Facility Requirements

4.3.1 Operating Space Required on Pier. 10 ft by 30 ft plus 17 ft width at main outriggers approximately 8 ft behind cab

4.3.2 Storage Space Requirements.

4.3.2.1 Cable Handling Boom Truck. 8 ft by 30 ft - 240 ft^2

4.3.2.2 Forklift. 5 ft by 8 ft - 40 ft^2

4.3.2.3 Cable per Pallet. 4-1/2 by 4-1/2 by 1-1/2 ft high (can stack 3 high without damage)
550 ft^2 per 10,000 ft of cable

5.0 SPECIFICATIONS

5.1 Specification-Truck, Cable Handling, Boom

Complete specification can be found in Appendix A.

5.2 Modifications/Attachments

5.2.1 Hydraulic Tool Circuit Modification to Standard, Commercial Boom Truck (See Figures 5-1 and 5-2). (Used if modifying rental equipment not acquired using previous equipment specification-5.1.) Parts and materials lists can be found in Appendix B.

5.3 Implementation Strategies

5.3.1 Equipment Allowance and Requirements Submission and Procurement. NAVFACINST 11200.12H of 8 September 1983, Section 5, provides guidance for submission of equipment allowance and requirements data during annual review cycles. Equipment allowance and requirements data is submitted in October of each Fiscal Year (FY) for allowance approval in the following FY (FY+1) and approval for procurement in the budget year (FY+2). Therefore, with the earliest submission available in FY85 and assuming high activity equipment priority, equipment procurement would occur in early FY87 with delivery estimated 12 to 18 months later.

Allowance and requirements data should be completed as shown in the following example (Figure 5-3) using quantities as determined in Section 3.3 based on equipment requirements and cost/benefit analysis during next activity Allowance and Requirements Review.

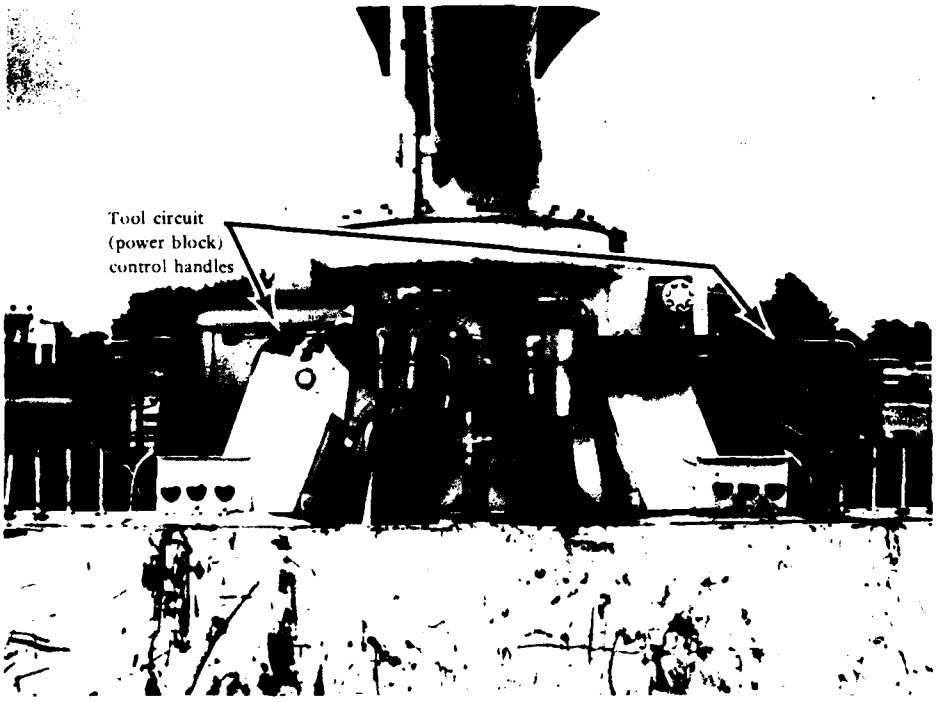
5.3.2 Equipment Lease. To fill immediate mission requirements for cable handling equipment in support of Fleet operations, a rented or leased unit may be acquired after approval to lease had been obtained from the cognizant Transportation Equipment Management Center (TEMC). In accordance with NAVFAC P-300, Chapter 3, full time hire should be considered: when it will result in cost benefits to the Government; or when unforeseen requirements develop which must be satisfied before vehicles can be obtained through annually-approved procurement programs. Requests to the TEMC for full time hire of vehicles for cable handling should include: (1) number of vehicles required; and (2) economic justification for hire (see Section 3.3). Additionally, full time hire should be considered when the mission cannot be feasibly accomplished by other methods or existing Navy-owned vehicles. Full time hire requests should be submitted by 1 July of each year.

The equipment specification for the cable handling boom truck (see Section 5.1) should be used for full time hire contracts.

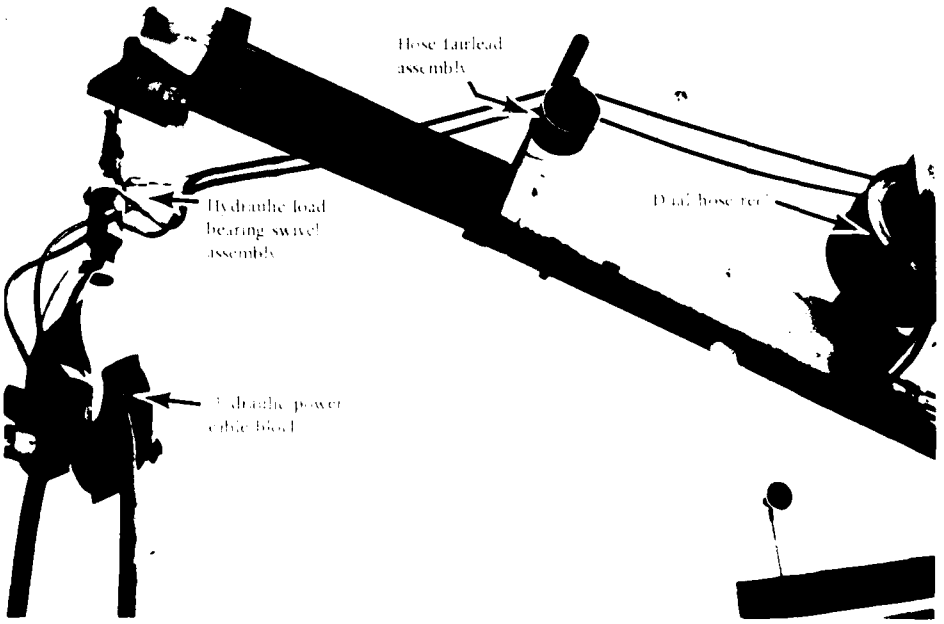
Special requirements for painting, marking, and data plates in accordance with paragraph 3.1.1 of the purchase description can be deleted and manufacturer's standard practice accepted for leased equipment.

5.2 Modifications/Attachments

5.2.1

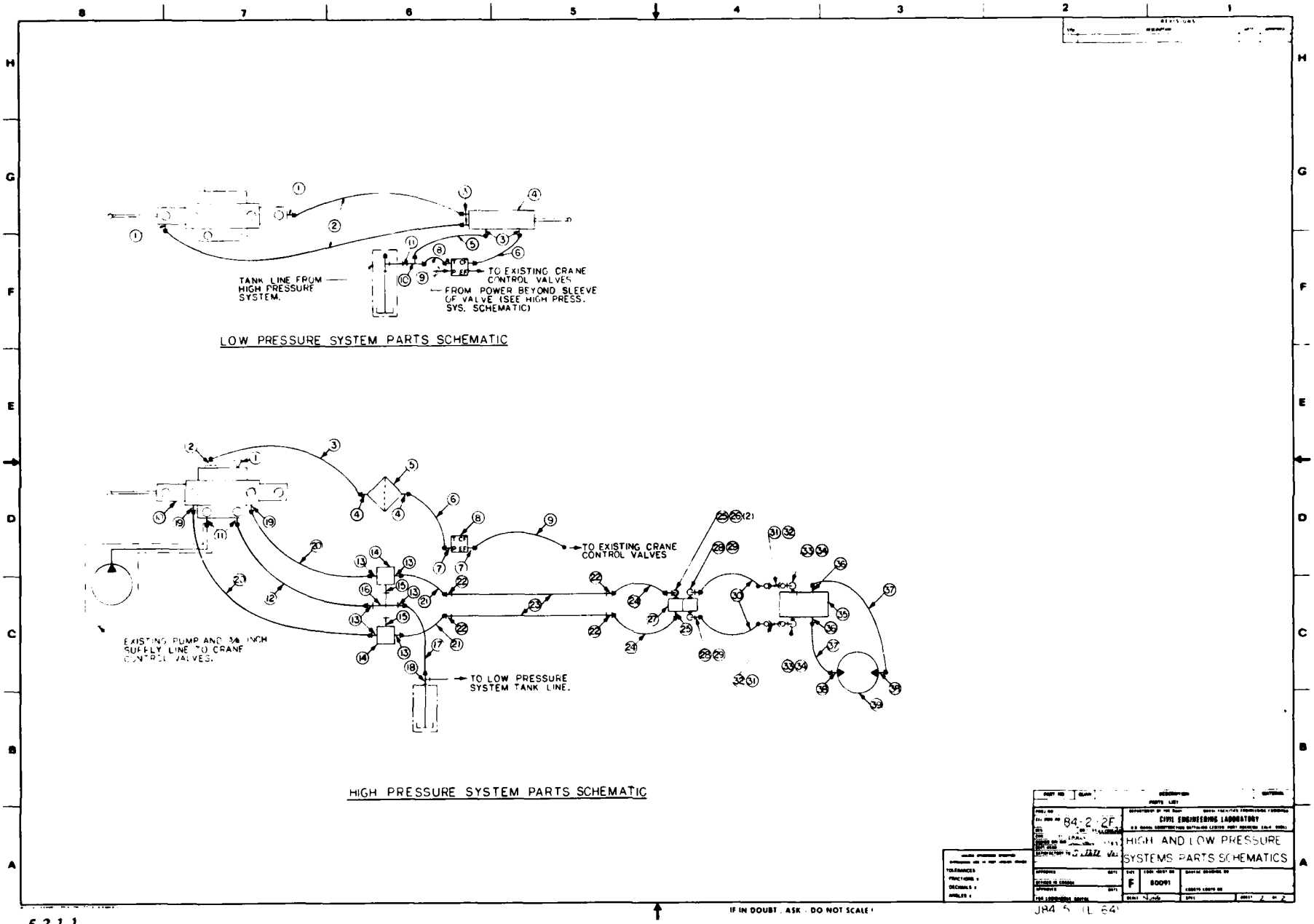


(a) Control valves, hoses, and fittings installed on crane pedestal near operator stations.



(b) Hose reel, fairlead assembly, hydraulic swivel, and power block installed on boom and load line.

Figure 5-1. Hydraulic tool circuit modifications to standard, commercial boom truck.



5.2.1.1

Figure 5-2. Hydraulic Systems Schematics

- SAMPLE -

Part A - Heading												
Submission Date		84	TEMC					TEMC UIC				
P1 Line		02	Activity					Activity UIC				
Resource Sponsor			Claimant					Claimant UIC				
Part B-Allowance Data			Part C-Requirements Data								Part D-Reqst Data	
ECC	Allowance Pres	Reqd	Inv	Due In	ECC/TC	USN	Description and Mfg	Yr	Sub ECC	Accum Mi/Hr	Act Pri	ECC and Type
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
0735	0	2	none								0001	073501

Figure 5-4. Sample case/MIS computer generated activity allowance and requirements review.

6.0 CONSTRUCTION/PRODUCTION

6.1 First Article Test Data

First article test data for equipment procured under the equipment specification provided in Section 5.1 of the User Data Package is incorporated in paragraph 4, "Quality Assurance Provisions," of the specification. Paragraph 4 outlines performance tests and inspection requirements to insure contractor compliance to contract requirements and specifications.

6.2 Installation Options

Two options exist for acquiring commercial truck-mounted hydraulic booms to handle electrical shore power cable. The first option is to procure or lease equipment (lease/purchase option) which meets requirements of the equipment specification for the cable handling, hydraulic boom truck (see Section 5.1). This option requires no modifications, however, to procure or lease equipment which meets the specification requirements requires a long lead time (minimum 6 months from contract award).

The second option allows for leasing of a standard commercial truck-mounted hydraulic boom with an immediate delivery after contract award. Navy modifications will cost $14,000 to $15,000 in materials and requires approximately 100 manhours for installation. For this option, all components of the low and high pressure hydraulic system modification (see Section 5.2) are required.

Overall cost for both options is approximately equal. The second option offers shorter lead time from the decision to implement to start of operations and potentially lower risk to test new cable handling operations by leasing standard equipment. The disadvantages are that: standard leased equipment is likely to be "used" with increased maintenance costs; provides fewer operator safety options, and requires removal of Navy installed equipment when equipment rental is discontinued.

6.3 Personnel Skill Levels/Training Requirements

6.3.1 Personnel Skill Levels.

6.3.1.1 Modification Installation Personnel.

- Machinist - aluminum and steel
- Welder - aluminum and steel
- Equipment Mechanic - knowledge of hydraulics, electrical (automotive)

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6.3.1.2 Equipment Operating Personnel.

- Journeyman Electrician possessing demonstrated skill in safe operation of hydraulic operated equipment (recommended WG-7 or greater)

6.3.2 Training Requirements. Operating personnel must as a minimum:

(1) attend safety course (suggested course outline in Section 3.1.2)

(2) pass test covering safety course material

(3) demonstrate safe equipment operating skills in accordance with performance test established by NAVFAC P-306 and/or activity under the guidance of the activity's weight handling equipment test instructor (recommended test in Section 3.1.2)

(4) possess a valid equipment operator's license prior to using equipment in cable handling operations

7.0 MAINTENANCE/OPERATION

7.1 Integrated Logistics Support (ILS) Requirements

Using MIL-STD-1388 as guidance, a preliminary logistic support engineering analysis was performed on the cable handling boom truck (crane and power block). The purpose of the LSA is to provide the logistics support requirements in the following areas:

- Maintenance Planning
- Supply Support
- Support Equipment
- Facilities
- Technical Documentation
- Personnel and Training
- Packaging, Handling, Storage, and Transportation (PHST)

The LSA performed encompassed a detailed study of the crane manufacturers' parts and maintenance manual and the Marco power block instruction manual. In addition, the reliability and maintainability engineering analysis performed (see Appendix C) provided major inputs to the LSA. The subsequent analysis addresses the qualitative and quantitative requirements for the above logistics areas.

7.1.1 Maintenance Planning. Maintenance planning documents in this section include the maintenance concept and plan for the cable handling boom truck.

The maintenance concept summarizes overall organizational, intermediate, and depot level maintenance to be performed by operator and maintenance personnel.

The maintenance plan includes policies and procedures identified in the Maintenance Requirements section and the LSA worksheets.

The LSA worksheets describe the various preventive maintenance tasks and level of repair and replacement for corrective maintenance tasks. Data for the LSA worksheet were extracted from Pitman Manufacturing Co. and Marco power block manuals. The LSA worksheets provide general guidelines for maintenance tasks. Note that component part numbers would vary from those listed for different manufacturers' equipment.

7.1.1.1 Maintenance Concept.

1. Organization (O) Level

a. Operator Personnel. Tasks include visual inspections and preventive maintenance. (These are annotated on the preventive maintenance schedule.)

b. No maintenance personnel are assigned at organizational level resulting in no corrective maintenance being performed at this level.

2. Intermediate (I) Level

I-level maintenance includes those tasks that will be performed by the Heavy Machinery Branch located at Public Works or contractor (i.e., heavy service contract). This consists primarily of removing and replacing various equipment and assemblies. In addition, some repair of various equipment and assemblies will be performed. The LSA worksheet indicates specifically which maintenance will be performed by the I-level maintenance personnel.

3. Depot (D) Level

D-level maintenance consists of the repair of those equipment and assemblies removed at the I-level. It also includes those tasks beyond the I-level capability. D-level maintenance, if required, will be contracted.

7.1.1.2 Maintenance Plan. Public Works activities should develop policies and procedures in accordance with guidelines provided in the Maintenance Requirements section. Maintenance planning documents consist of the LSA worksheets and lubrication schedule. The LSA worksheets provide the corrective and preventive maintenance task data associated with the crane and power block.

7.1.1.2.1 Maintenance Requirements.

Cable Handling Boom Truck

Preventive Maintenance

1. Operator's Daily Checklist. A licensed boom truck operator shall perform daily inspection of equipment as prescribed in NAVFAC P-300, Chapter 21. Any equipment deficiencies shall be reported immediately to the supervisor before putting equipment into operation. See Figure 7-1 for sample checklist.

2. Operator Lubrication Schedule. General lubrication of equipment shall be performed by equipment operators with assistance from one or two personnel in accordance with equipment manufacturers' recommendations (usually found in operator's manual). Sample lubrication instructions and equipment lubrication chart are shown in Figures 7-2 and 7-3.

USN No._____ Type Equip _____ Hourmeter Hours Operated____Date _____

Engine Start _____Stop _____

Hyd. System Start_____Stop_____

Operators Name_____ Shift 1 2 3 Instructions - Check all items. Inspect and indicate as satisfactory (S) or unsatisfactory (U).

Walk Around Inspection	S	U
Safety Guards		
Securing Hardware (pins etc.)		
Leaks (cylinders, hoses etc.)		
Wire Rope Layering on Winch		
Wire Rope in Sheaves		
Wire Rope Condition		
Boom (structural)		
Hook		
Outriggers (pins, leaks)		
Structural (welds, cracks)		
Mounting Hardware (bolts)		
Lubrication		
Hydraulic Reservoir + Filter		
Hydraulic Safety Equipment		
Power Block		

Truck and Chassis	S	U
Engine		
Battery		
Oil/Water Levels		
Leaks (fuel/oil/water)		
Lights		
Frame (cracks, welds)		
Suspension (springs)		
Tires (inflation, cuts)		
Wheels (loose studs)		
Brakes		
Safety Equipment		
Hourmeters		
Gauges		

Operator Platform	S	U
Operator Safety Guards		
Platform/Handrails		
Warning/Indicator Lights		
Stop/Start Switch		
Load Rating Charts		
Boom Angle Indicator		
Level Indicator		
Leaks (control valves)		
Controls		
Warning Placards		
Safety Devices		

Operation Inspection	S	U
Unusual Noises		
Control Action		
Boom Functions		
Crane Stability		
Limit Switch/Anti Two Block		
Power Block Function		
No Load Test		

NOTE: Suspend all operations immediately when observing an unsatisfactory condition or unsafe condition and notify supervisor. Conditions of interest not affecting safety should be noted in "Remarks" section.

Operators Signature_____

Date_____

Supervisors Signature_____

Date_____

Remarks _____

_____

_____

_____

_____

_____

_____

_____

Figure 7-1. Sample Operator Daily Checklist

LUBRICATION POINT	TYPE LUBRICANT	APPLICATION	INTERVAL
Control linkage, minor hinge points	SAE 10-10W Oil	Oil Can 	Maintain a light coating.
Topping cylinder pivot bushings, boom pivot bushings, pump drive shaft yoke ends, boom tip sheaves.	Mobiltac E, Texaco Crater compound, or equivalent open gear lubricant	Pressure gun or Hand gun. 	Weekly
Rotation Turntable Bearings	Mobilgrease 77 or equivalent No. 2 EP grease		Every 100 hours.
Rotation Gear Box	*SAE 140 Gear Oil*	*Fill to Check Plug* Level. 	*Fill before initial operation.* See specific lubrication instructions.
Rotation Turntable Gear Teeth	Mobiltac E, Texaco Crater compound, or equivalent open gear lubricant.	Hand or Brush Applied 	As required to prevent metal-to-metal contact.
Winch Reduction Housing	SAE 90 Gear Oil meeting API-GL-3	Fill to Check Plug Level. 	Six months
Hydraulic Throttle	Brake Fluid	Fill Reservoir 	As required

Figure 7-2. Crane lubrication instructions.

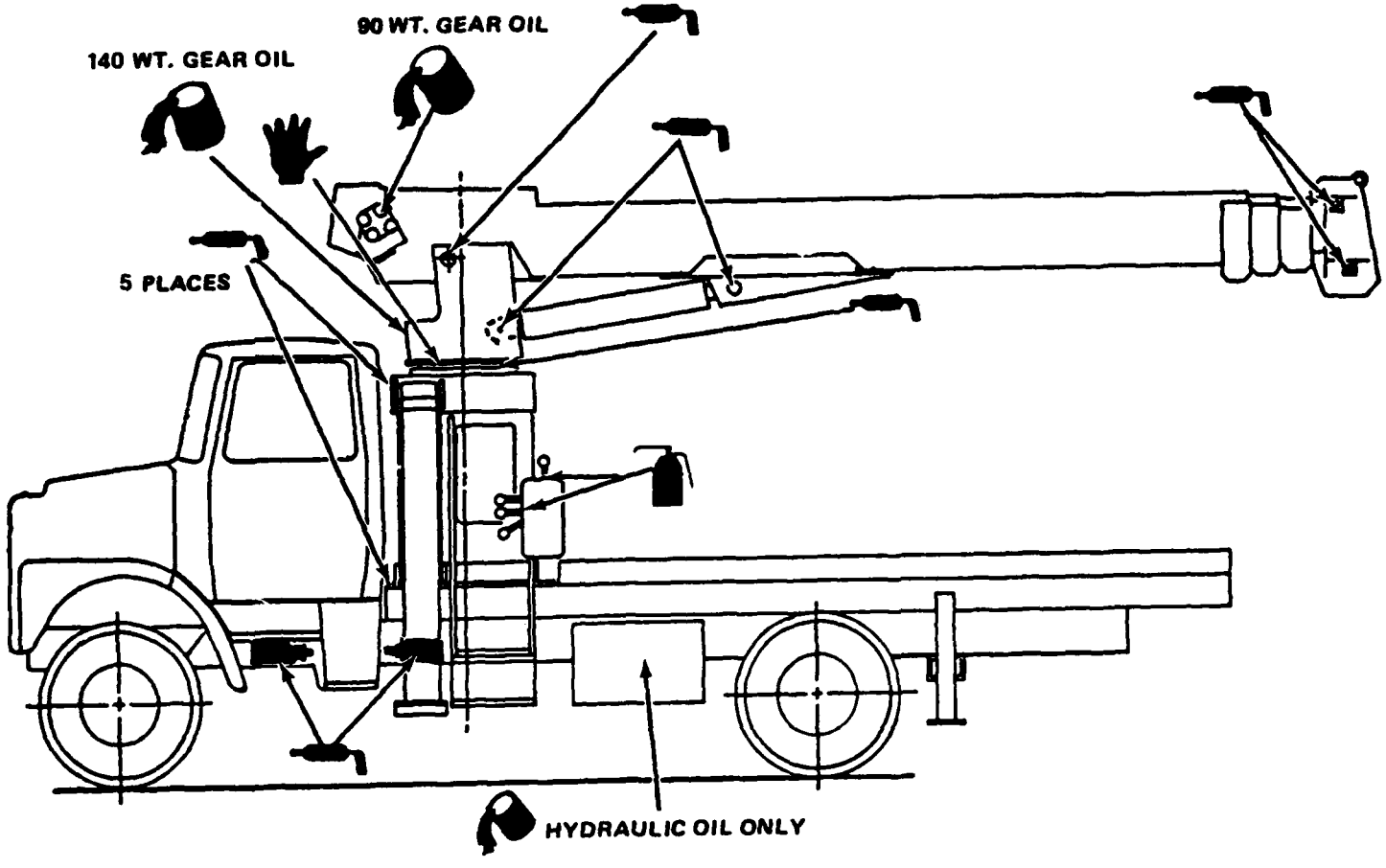


Figure 7-3. Crane lubrication chart.

3. Periodic Inspection. Periodic inspection should be performed by qualified equipment maintenance personnel (i.e., Public Works Transportation - Heavy Equipment Maintenance Branch) at intervals in accordance with equipment manufacturers' recommendations. Periodic inspection should be performed semiannually or after 500 hours of hydraulic boom operations, whichever comes first. Inspection should include, as a minimum:

- identification of structural damage to boom or mainframe
- evidence of abnormal wear of cylinders or motors
- torquing of all mounting bolts, particularly in turret assembly
- inspection of hydraulic system oil and filter condition
- wire rope inspection and maintenance as required
- lubrication of truck chassis and driveline components as required
- adjustment of relief or holding valves, particularly those used as safety devices

Corrective Maintenance

1. Operator Level Maintenance. Equipment operators should provide corrective maintenance to tighten leaking hoses or hydraulic fittings with available tools. Otherwise, equipment malfunctions should be repaired by qualified hydraulic equipment maintenance personnel. Operators should provide maintenance personnel with information to localize component failures (e.g., boom does not swing but other crane functions work normally).

2. Intermediate Level Maintenance. Corrective maintenance of the cable handling boom truck shall be performed by Public Works Transportation Heavy Equipment Repair Branch or equipment maintenance contractor as applicable. Maintenance actions shall be performed in accordance with equipment manufacturers' maintenance manual provided with equipment. Troubleshooting guidelines are found in maintenance manuals, or the worksheets in Appendix C pages C-12 through C-18 can be used.

Test Requirements After Maintenance

A load test and inspection shall be performed on the cable handling boom truck after maintenance actions have been performed on any load bearing, load controlling, or safety devices (e.g., outrigger cylinder repair, holding valve replacement in boom lifting cylinder).

Corrective Maintenance Predictions - Reliability/Maintainability Data

A reliability and maintainability analysis was performed on a PITMAN Hydra Lift 1064 truck-mounted hydraulic boom with attached power block. This analysis applies to all equipment that comprises the cable handling boom truck regardless of manufacturer. The analysis predicted:

- approximately one failure per year (estimated 2,000 operating hours between failures)
- average time for corrective maintenance repair of 2 hours (does not include delays awaiting parts, etc.; includes only active repair time)
- maintenance manhour to operating hour ratio (MMH/OH) of 0.064 (64 hours of preventive and corrective maintenance per 1,000 hours of operation)

The analysis is provided in Appendix C pages C-3 through C-28.

Support Equipment Maintenance

Equipment used to support cable handling operations using the cable handling boom truck, such as forklifts or cable reeling equipment, shall be maintained in accordance with manufacturers' recommendations either by operators or maintenance personnel as currently required by Public Works activities.

7.1.1.2.2 LSA Worksheets. The number in parentheses refers to the identical column in the worksheet.

(1) Lists the equipment, assembly, or component being maintained.

(2) Lists the drawing number of the equipment, assembly, or component.

(3) Lists the manufacturer of the equipment, assembly, or component.

(4) Describes the preventive maintenance associated with each item identified in (1).

(5) Lists the level of maintenance where the corrective maintenance task (i.e., removal, replacement, and repair) will be performed. The three levels of maintenance are: Organizational (O), Intermediate (I), and Depot (D).

O-level maintenance includes those tasks performed by the operator or maintenance personnel at the level.

I-level maintenance includes those tasks performed by maintenance personnel at the Heavy Machinery Branch.

D-level maintenance includes those tasks performed by a contract repair facility.

(6) Lists additional information associated with the equipment identified in column 1.

LSA worksheets are attached as Table 7-1 (3 pages).

7.1.2 Supply Support. Since D-level maintenance will be completely contracted and there is no organizational level maintenance, there will be no need for either level. The I-level supply support requirements are included in this section. The O-level and I-level spares and consumables are provided in Tables 7-2 and 7-3, respectively. Only the major equipment and assemblies are addressed. The numerous elbows, tees, and straight pipes that comprise the crane and power block are considered readily available from many sources and, therefore, it is not recommended to stock these items.

7.1.3 Support Equipment. This section identifies the support equipment (i.e., test equipment and tools) requirements necessary to maintain the crane and power block. O-level and I-level tools are identified in Tables 7-4 and 7-5.

7.1.4 Facilities. This section of the LSA identifies the facilities required to support the crane and power block throughout operations, storage, and maintenance. Dimensions were extracted from the Pitman Maintenance and Parts Manuals. The operations requirements will show the maximum space required for operation of the crane and power block on the pier. The storage requirements will provide the space required when the crane is parked. The maintenance requirements will provide the minimum space required to perform I-level maintenance on the crane. The dimensions for the crane are shown in Figure 7-4. This diagram provides the dimensions for both storage and maintenance.

Crane and power block operation dimensions are provided in Table 7-6.

7.1.5 Personnel and Training.

7.1.5.1 Equipment Maintenance.

1. Personnel. For maintenance of commercial truck-mounted cranes, personnel required are as follows:

- machinist (aluminum and steel)
- welder (aluminum and steel)
- equipment mechanics with knowledge of hydraulics, cranes, automotive electrical

2. Training. None required.

7.1.5.2 Equipment Operations

SYSTEM Crane & Power Block
SUBSYSTEM
EQUIPMENT Crane & Power Block

LSA
LOGISTICS SUPPORT ANALYSIS
Crane and Power Block

PAGE 1 OF 3
DATE

1. EQUIPMENT	2. MANUFACTURER	3. MODEL PART NUMBER	4. PREVENTIVE MAINTENANCE			5. CORRECTIVE MAINTENANCE		6. REMARKS
			FREQUENCY	TASK	LEVEL	REMOVE REPLACE	REPAIR	
1. Power Takeoff	Waterous	--	Weekly	Check for adequate lubrication & mounting alignment	O	I	D	
2. Tandem Pump	Commercial	--	Quarterly	Check security of mounting bolts.	O	I	D	
3. Filter	Pitman	508-00-0024	Quarterly	Replace as required.	O	I	--	
4. Strainer	Pitman	508-00-0027	Quarterly	Replace as required.	O	I	--	
5. Selector Valve	Pitman	601-17-0065	Quarterly	Check for proper operation.	O	I	D	
6. Winch Manifold and Relief Valve	Pitman	601-00-2590	Quarterly	Check for proper operation.	O	I	D	
7. Winch Control Valve	Pitman	601-00-1410	Quarterly	Check for proper operation.	O	I	D	
8. Winch Motor and Gear	Pitman	603-00-0969 (M00378)	Quarterly	Check for security of mounting bolts.	O	I	D	

Table 7-1

SYSTEM Crane & Power Block
SUBSYSTEM
EQUIPMENT Crane & Power Block

LSA
LOGISTICS SUPPORT ANALYSIS
Crane and Power Block

DATE

1. EQUIPMENT	2. MANUFACTURER	3. MODEL PART NUMBER	4. PREVENTIVE MAINTENANCE			5. CORRECTIVE MAINTENANCE		6. REMARKS
			FREQUENCY	TASK	LEVEL	REMOVE REPLACE	REPAIR	
9. Boom Control Valve	Pitman	601-17-3334	Quarterly	Check for proper operation.	O	I	D	
10. Swing Control Valve	Pitman	601-00-2507	Quarterly	Check for proper operation.	O	I	D	
11. Boom Telescoping Control Valve	Pitman	601-00-2665	Quarterly	Check for proper operation.	O	I	D	
12. Boom Cylinder #1	Pitman	040-58-0297	Daily	Check for leaks.	O	I	D	
13. Swing Motor	--	M00133	Quarterly	Check for security of mounting bolts.	O	I	D	
14. Swing Gears	--	W00288	Monthly	Check oil level.	O	I	D	
15. Boom Cylinder #2	Pitman	040-70-0283	Daily	Check for leaks.	O	I	D	
16. Boom Cylinder #3	Pitman	040-70-0282	Daily	Check for leaks.	O	I	D	

Table 7-1 (continued)

SYSTEM Crane and Power Block
SUBSYSTEM
EQUIPMENT Crane & Power Block

LSA
LOGISTICS SUPPORT ANALYSIS
Crane and Power Block

PAGE 3 OF 3
DATE

1. EQUIPMENT	2. MANUFACTURER	3. MODEL PART NUMBER	4. PREVENTIVE MAINTENANCE			5. CORRECTIVE MAINTENANCE		6. REMARKS
			FREQUENCY	TASK	LEVEL	REMOVE REPLACE	REPAIR	
17. Holding Valves	Pitman	601-00-2241 601-00-2242 601-00-2544 601-00-2590	Weekly	Perform holding valve test.	O	I	D	
18. Outrigger Manifold and Relief Valve	Pitman	601-17-3338	Quarterly	Check for proper operation.	O	I	D	
19. Outrigger Cylinders	Pitman (main) (aux)	040-70-0375 040-70-0386	Daily	Check for leaks.	O	I	D	
20. Hydraulic Power	MARCO	--	Quarterly	Check for proper operation.	O	I	D	
21. Motor Power Block	MARCO	16613	Quarterly Yearly	Check for security of mounting bolts. Lubrication	O O	I	D	
22. Swivel	--	--	Quarterly	Check for leaks and security of working bolts.	O	I	D	
23. Flow Divider Valve	Pitman	601-00-1121	Quarterly	Check for proper operation.	O	I	D	

Table 7-1 (continued)

Table 7-2. I-Level Spares Cable Handling Boom Truck

Quantity	Description	Use/Remarks
1	Valve, counterbalance	Installed between 2nd and 3rd stage boom extension cylinders
1	Valve, holding	3rd stage extension cylinder
1	Valve, holding	2nd stage extension cylinder
1	Valve, shuttle	Diverts fluid from either work-port of control valve to pilot operated motor brake (boom swing function)
1	Valve, holding (winch)	Used to hold planetary winch load
1	Valve, motion control	Prevents shock loads in boom rotation gearbox
1	Motor, hydraulic (swing)	Input to boom rotation gearbox
1	Motor, hydraulic (winch)	Input to winch gear reduction unit
1	Valve, holding (topping)	Used to hold loads of boom topping cylinder
1	Valve, holding (outrigger)	Used to hold outrigger position (extended or retracted)
1	Valve, control	3-position, 4-way, 20-gpm directional control valve for all boom functions or outriggers (pilot operated valve for Pitman only)
1	Valve, winch, control	3-position, 4-way, 40-gpm directional control valve (pilot operated valve for Pitman only)
1	Valve, remote, pilot	(Pitman only - for above control valves)
1	Valve, flow divider	(Pitman only - for remote low pressure supply)
1	Valve, selector	(Pitman only - for outrigger or boom control selection)
1	Valve, check, inline	For hydraulic system protection in combining tandem pump flows for winch
1	Motor, power block	Ross torque motor, MAB-08, standard mount, 6-B spline
1	Sheave, power block w/ribbed rubber	Marco part #53364 for replacement of sheave where rubber wears down
1	Filter, cartridge	10-micron replacement cartridge for hydraulic reservoir

continued

Table 7-2. Continued

Quantity	Description	Use/Remarks
1	Strainer, suction	Strainer replacement for hydraulic reservoir
1	Swivel assembly, hose reel	Swivel replacement for power block function hose reels
1	Swivel, dual hydraulic load carrying (repair kit)	Mobile Equipment Co., Model #LCS-8 allows free rotation of power block while maintaining hydraulic pressure
1	Filter, element	10-micron filter replacement (use only if Navy modification per NCEL dwg #84-2-2F

Table 7-3. Cable Handling Boom Truck Consumables

	Lubricant
1.	SAE 10-10W oil (light coating of control valves, linkages)
2.	Open gear lubricant (spray) (turntable gear teeth, power block ring gear)
3.	No. 2 extra pressure grease - cartridge tubes (pins, bushings, gears)
4.	SAE 90 gear oil (meets API-GL-3) (winch gear reduction)
5.	SAE 140 gear oil (boom rotation gearbox)
6.	Brake fluid (hydraulic accelerator, if provided, brakes)
7.	Hydraulic fluid (petroleum-based for local operating temperatures)
8.	Hoses and hose fittings (medium and high pressure hydraulic - various sizes)

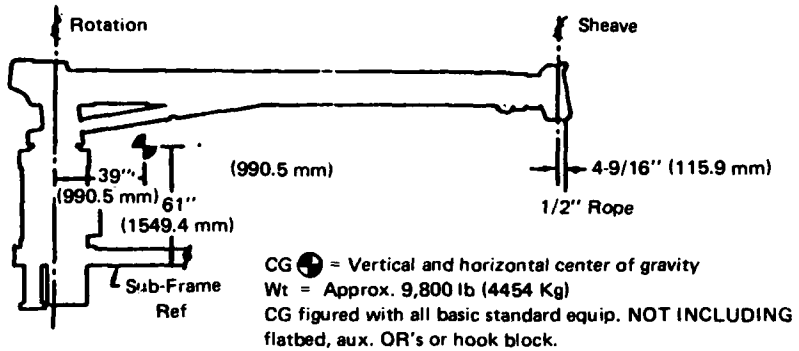
Table 7-4. O-Level Support Equipment

Quantity	Description
1	Grease gun with flexible hose and fittings
1	Wrench, 15-in. crescent
1	Wrench set, open end, 3/8-1-1/8-in., 1/16-in. increments
1	Hammer, ball peen, 16-oz
1	Wrench, vise grip 8-1/2-in.
1	Wrench, vise grip 5-1/2-in.
1	Screwdriver, 12-in., straight blade
1	Wrench set, Allen, hexkey 1/64-3/8-in., 1/64-in. increments
1	Oiler, pump, 4-oz
1	Sealant, Locktite, pipe (tube)
1	Clipboard

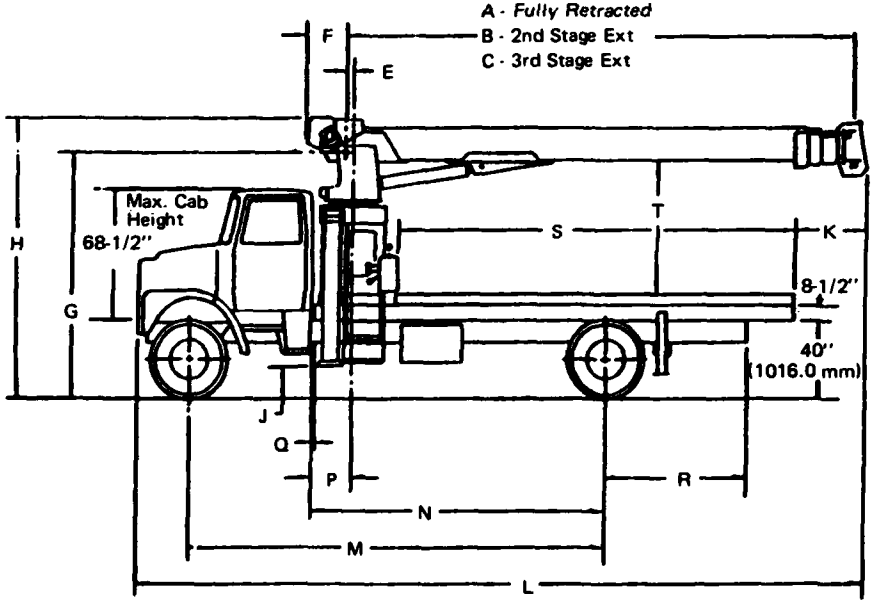
Table 7-5. I-Level Support Equipment

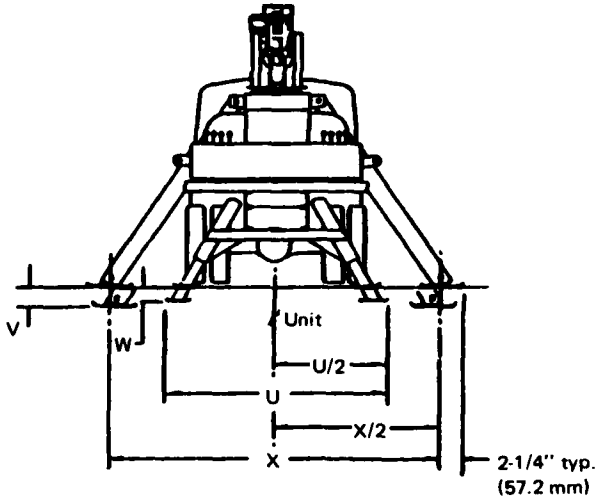
Quantity	Description
1	Miscellaneous hand tools (mechanic)
1	Hoist - 2,000-lb capacity
1	Hydraulic bench press
1	Torque wrench - 450-lb capacity
1	Socket sets
1	Drive punch sets
1	Snapring pliers sets
1	Assorted prybar set
1	Gauge, 0-300 psi

Dim.	Description	III-1064 3-Stage
A	℄ Boom Pivot/℄ l.w.r. Sheave Pin-Fully Ret.	270" (6858 mm)
B	℄ Boom Pivot/℄ l.w.r. Sheave Pin-2nd Stg. Ext.	462" (11,734.8 mm)
C	℄ Boom Pivot/℄ l.w.r. Sheave Pin-3rd Stg. Ext.	654" (16,611.6 mm)
E	℄ Boom Pivot/℄ Rotation	5" (234.9 mm)
F	℄ Boom Pivot/End Winch Cover	19-1/4" (234.9 mm)
G	℄ Boom Pivot/Ground	127" (3225.8 mm)
H	Pop Winch Cover/Ground	145" (3683.0 mm)
J	Outrigger Clearance	17" (431.8 mm)
K	Bed End/Ret. Boom Tip	29" (736.6 mm)
L	Machine Overall Length	410" (1041.4 mm)
M	Truck Frame Wheel Base	222" (5638.8 mm)
N	Truck Frame Cab/Axle	144" (3657.6 mm)
P	Truck Frame Cab/℄ Rotation	25" (635.0 mm)
Q	Cab Clearance/Subframe	1" (254 mm)
R	Truck Frame Axle/End Frame	75" (1905.0 mm)
S	Bed Length	220" (5588 mm)
T	Bed Clearance/Boom	69" (1762.6 mm)
U	Max. Aux. Outrigger	128-1/2" (3264 mm)
V	Max. Main Outrigger Penetration	8" (203 mm)
W	Max. Aux. Outrigger Penetration	8-1/2" (222 mm)
X	Max. Main Outrigger Spread Pin/Pin	186" (472 mm)



CG ⊕ = Vertical and horizontal center of gravity
Wt = Approx. 9,800 lb (4454 Kg)
CG figured with all basic standard equip. NOT INCLUDING flatbed, aux. OR's or hook block.





Retracted Outrigger Width		
Main OR	85"	2159.0 mm
Aux OR	96"	2438 mm

Figure 7-4. Facility requirements.

Table 7-6. Dimensions

Category	Dimension
1. Maximum Tip Sheave Height to Ground	64 ft 4 in.
2. Overall Height (Boom Stowed)	12 ft 1 in.
3. Boom Vertical Travel	-15 to +80 deg
4. Retracted Boom Length	22 ft 6 in.
5. Horizontal Boom Reach	54 ft 6 in.
6. Main Outrigger Spread	15 ft 6 in.
7. Rear Auxiliary Outrigger Spread	10 ft 7 in.

1. Personnel. Cable handling boom truck operations require a journeyman electrician with a valid license and demonstrated skill in safe operation of hydraulic equipment (recommended WG-7 or higher).

2. Training. Operating personnel must complete the following training, as a minimum:

a. Attend safety course (suggested course outline in Section 3.1.2)

b. Pass test covering safety course material

c. Demonstrate safe equipment operating skills in accordance with performance test established by NAVFAC P-306 and/or the activity under the guidance of the activity's weight handling equipment test instructor (recommend test in Section 3.1.2)

d. Attend annual 8-hour refresher training courses conducted by activity.

7.1.6 Technical Documentation. The technical documentation required to support operations and maintenance of the cable handling boom truck includes:

1. Equipment manufacturer's operator, maintenance, and parts manuals

2. Handbooks or manuals covering technical data on manufacturer options not provided in manuals above

3. Truck and chassis manufacturers' manuals if not provided in manuals above

4. Marco Instruction Manual for Marco Puretic Power Block

5. Parts lists for Mobile Equipment Co.'s load carrying swivel

6. Troubleshooting and fault localization/isolation charts (Appendix C, pages C-12 through C-18)

7. Operator guidelines for cable handling operations (see Section 7.2)

7.1.7 Packaging, Handling, Storage, and Transportation (PHST). The PHST requirements for the crane and power block identified in this section provide information for shipping the equipment and assemblies required to support the repair of the crane and power block. The overall PHST program for the crane and power block shall be consistent with MIL-STD-1367, and packaging shall be performed with guidance from MIL-C-3580.

The dimensions provided in Section 7.1.4 above provide the overall dimensions when shipping or transporting the entire Cable Handling Unit.

All of the recommended spare parts will require shipping if the need arises. All can be shipped using best commercial practices and conforming to the requirements of the above two referenced specifications.

7.2 Guide Manual for Cable Handling Operations

7.2.1 General Safety Considerations.

1. Cable handling boom truck operators shall inspect equipment daily for safe operating condition prior to use. Licensed operators are responsible for equipment condition, which includes equipment lubrication.

2. When using equipment, operate controls slowly and smoothly to avoid sudden stops or jerking motion of the hydraulic boom, particularly when all three boom sections are fully extended.

3. Prior to handling the cable, it is a good practice to operate the power block in both directions. When equipment is idle for long periods (i.e., overnight), hydraulic pressure loss in the motor of the power block occurs and the rubber sheave of the power block can freewheel slightly.

4. When handling cable, particularly if pulling cable out from under obstructions (i.e., cables under a brow platform), the operator must avoid side loading of the hydraulic boom. To compensate for side loading, the operator should observe the position of the loadline and power block as the hydraulic control is operated to pull the cable. The sheave head (hydraulic boom tip) and boom should be positioned such that the loadline, power block, and sheave head are kept in a vertical plane (see Figure 7-5).

5. Extreme caution should be exercised when operating the cable handling boom truck around or near live electrical equipment. In general, this will apply to cable handling operations when installing cables aboard a berthed ship. Some ship classes, particularly the FFG-1 frigates and DD963 destroyers, have high voltage antennas near the location where cables go aboard ship. It is recommended that operators do not operate the hydraulic boom near these antennas unless ship personnel provide assurances that the antennas are deenergized. Do not take chances! If in doubt, ask!

6. Never operate the hydraulic boom unless the outriggers are fully extended and set on a firm surface. Outriggers are designed to stabilize the crane and their function is to shift the vehicle's weight from truck axles to the outriggers.

7.2.2 Loading Cable and Transporting to Pier.

The cable handling boom truck has been designed to carry 10-12 125-foot cable lengths (1,250-1,500 feet) that have been stored on 4- by 4-foot wooden pallets.

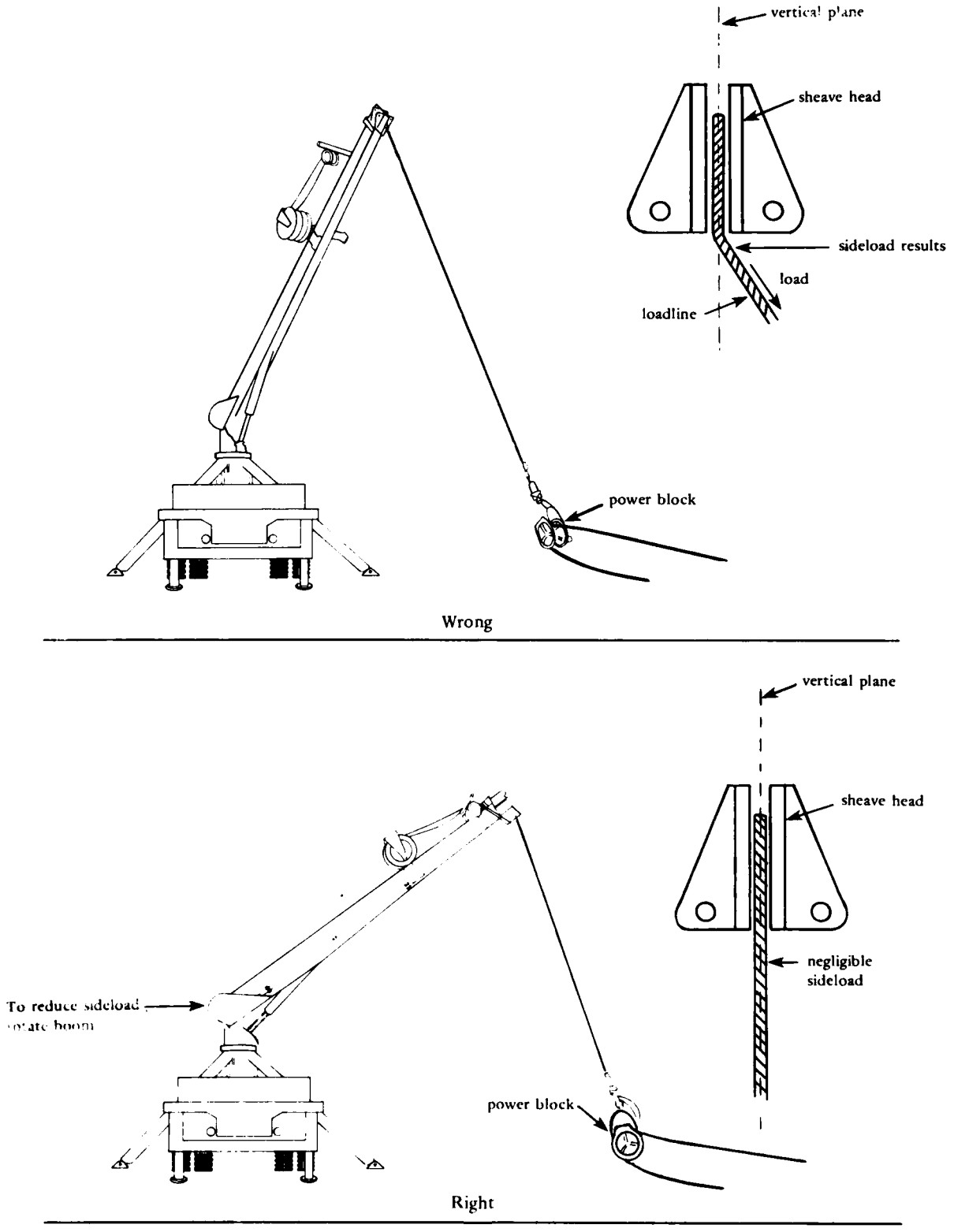


Figure 7-5. Minimizing boom sideloads.

Using a 6,000-pound forklift, load the truck bed evenly. Start loading cable pallets over or just forward of the truck rear axle on each side of the truck bed. Cables can be stacked two high on the truck. Then load additional cables by distributing them evenly forward and behind the rear axle and from side to side of the truck bed (see Figure 7-6). The vehicle's weight rating is based on loads distributed uniformly on the truck bed with most of the load centered over the rear axle. Proper loading of the boom truck is particularly important to the life of the vehicle.

Before transporting cables, inspect load to insure that the cables will not fall off the truck when turning or braking. On base travel is normally limited to 25-30 mph, so tying down the cables before moving the vehicle is not considered necessary. The boom truck driver should periodically observe the cables in the side mirrors while transporting them to a pier.

7.2.3 Cable Installation on the Pier. When laying cable on the pier, position the truck in a location to remove cable off the rear of the truck towards the pier electrical outlets. The boom pedestal (boom rotating base) should be approximately 80 feet from the pier outlets (see Figure 7-7). Additionally, the boom truck should be positioned to provide room between the pier edge and extended outrigger for laying down cables (usually 6 feet). Figures 7-7 and 7-8 illustrate an example of installing 125-foot cable lengths along the pier edge. The cable installation sequence is as follows:

1. Position the boom truck as shown in Figure 7-7.

2. Set the outriggers before operating the boom.

3. Raise the boom and lower the power block to pick up the first cable with 6-8 feet hanging over one side of the block.

4. Lower the boom while raising the power block to approximately 30 or 40 degrees from the horizontal.

5. Extend the boom sections fully while lowering the power block.

6. Rotate the boom and position the power block over the pier where the cable will be laid down (usually 10 to 20 degrees over the side).

7. Using two personnel, feed the cable over the power block and hand carry enough cable length to the pier outlets for connections (usually 20-25 feet).

8. Raise the boom while continuously feeding cable. Have ground personnel position the cable in a straight line along the pier edge. Periodically retract the boom to lower the power block and maintain a 15- to 25-foot height above the pier.

Figure 7-6. Cable handling boom truck loaded with palletized cables.

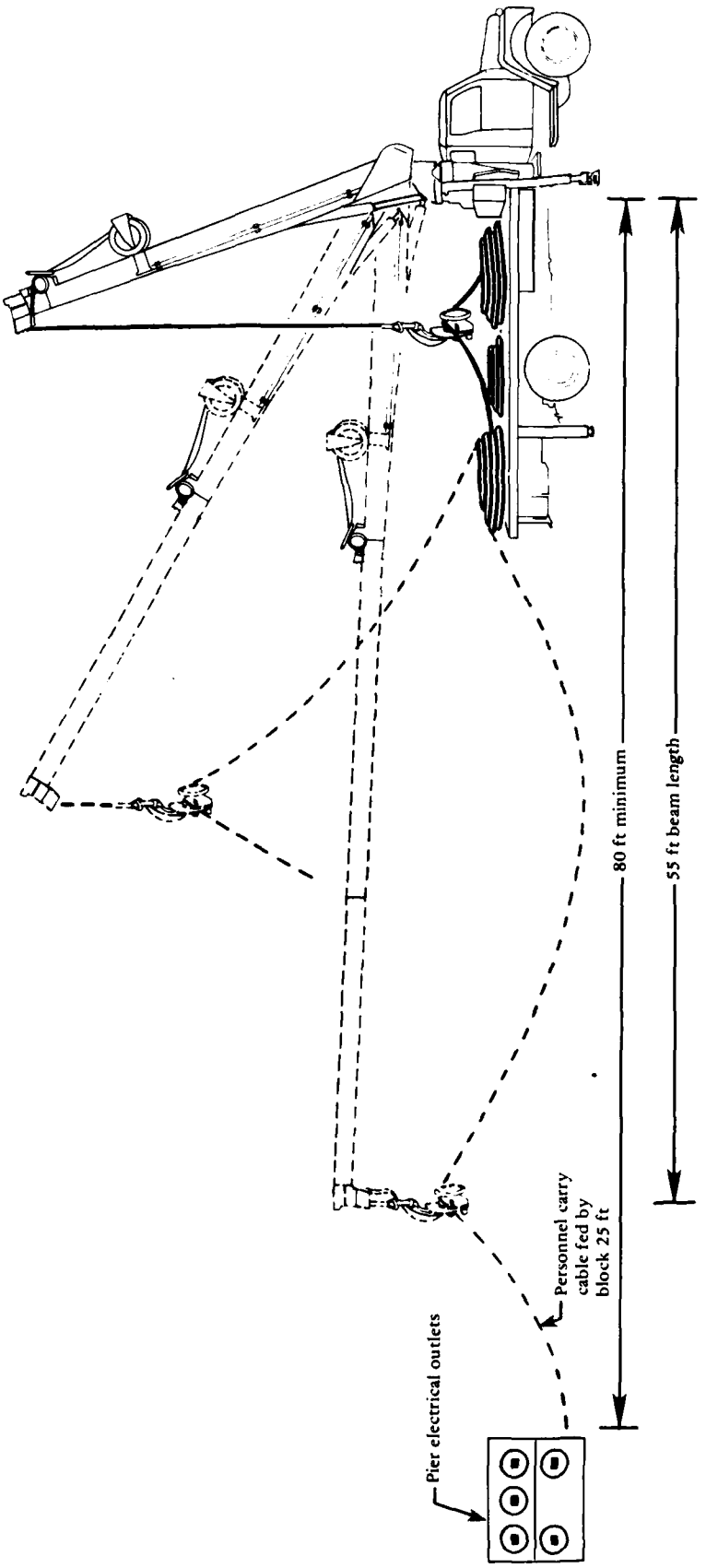


Figure 7-7. Cable layout on pier toward pier outlet.

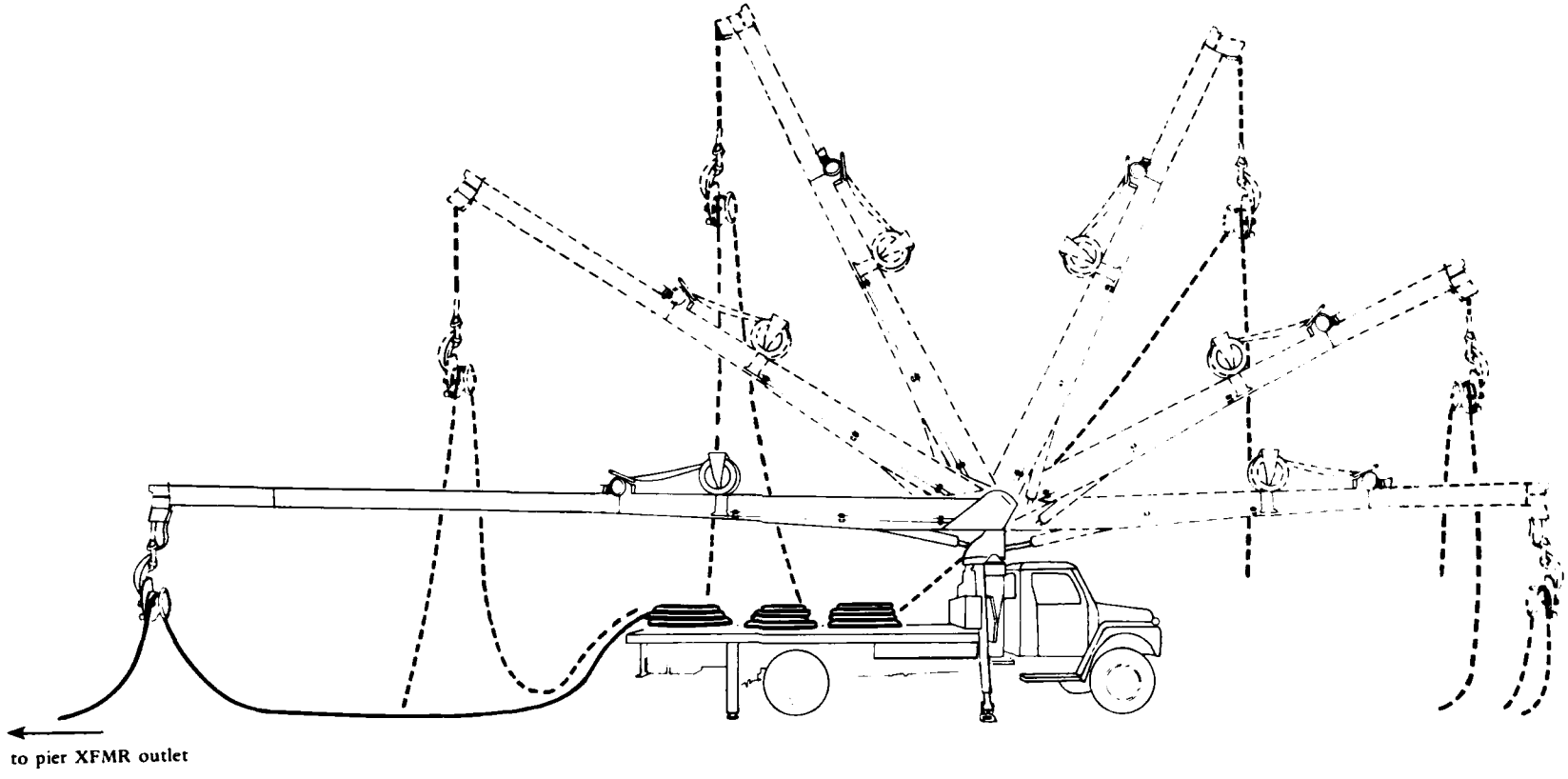


Figure 7-8. Cable layout on pier along pier edge from outlets.

9. The remainder of cable layout is difficult for the operator as he must raise and swing the boom while feeding cable over the power block (i.e., three functions - two hands). Generally, the boom can be rotated while feeding cable. Periodically the operator will raise the boom to keep the block moving parallel to the pier edge.

10. As the boom swings forward over the truck cab, the operator will lower and extend the boom periodically while feeding cable.

11. As the cable end nears the power block during layout, lower the power block to the pier. The final 4 to 5 feet of cable is best fed to ground personnel at a height of 3-4 feet above the pier.

12. Repeat the sequence from 3 through 11 for each cable.

13. Position the boom in traveling position and retract the outriggers.

7.2.4 Removing Cables From the Pier. For cable removal the boom truck should be positioned where the boom pedestal (boom rotating base) is near the middle of the cable length lying on the pier. Also, the truck position should allow enough room to extend the outriggers without moving the cables. Figures 7-9 and 7-10 illustrate an example of removing cables from the pier. Cable lengths up to 500 feet can be removed with this procedure. The cable removal sequence is as follows:

1. Position the boom truck as shown in Figure 7-9.

2. Set outriggers before operating the boom.

3. Raise the boom to approximately a 50-degree angle and swing the boom over the side of the truck over the cables.

4. Extend the first boom section while lowering the power block to pick up the first cable.

5. Ground personnel will insert the first cable in the block and the operator will raise the block to the boom tip.

6. The operator should rotate the power block to feed cable toward the rear of the truck. The block should be at least 30 to 40 feet in the air to prevent side loading when pulling cable. Feed cable until 6 to 8 feet of cable hangs from the power block (the remainder of the cable will form a coil on the pier).

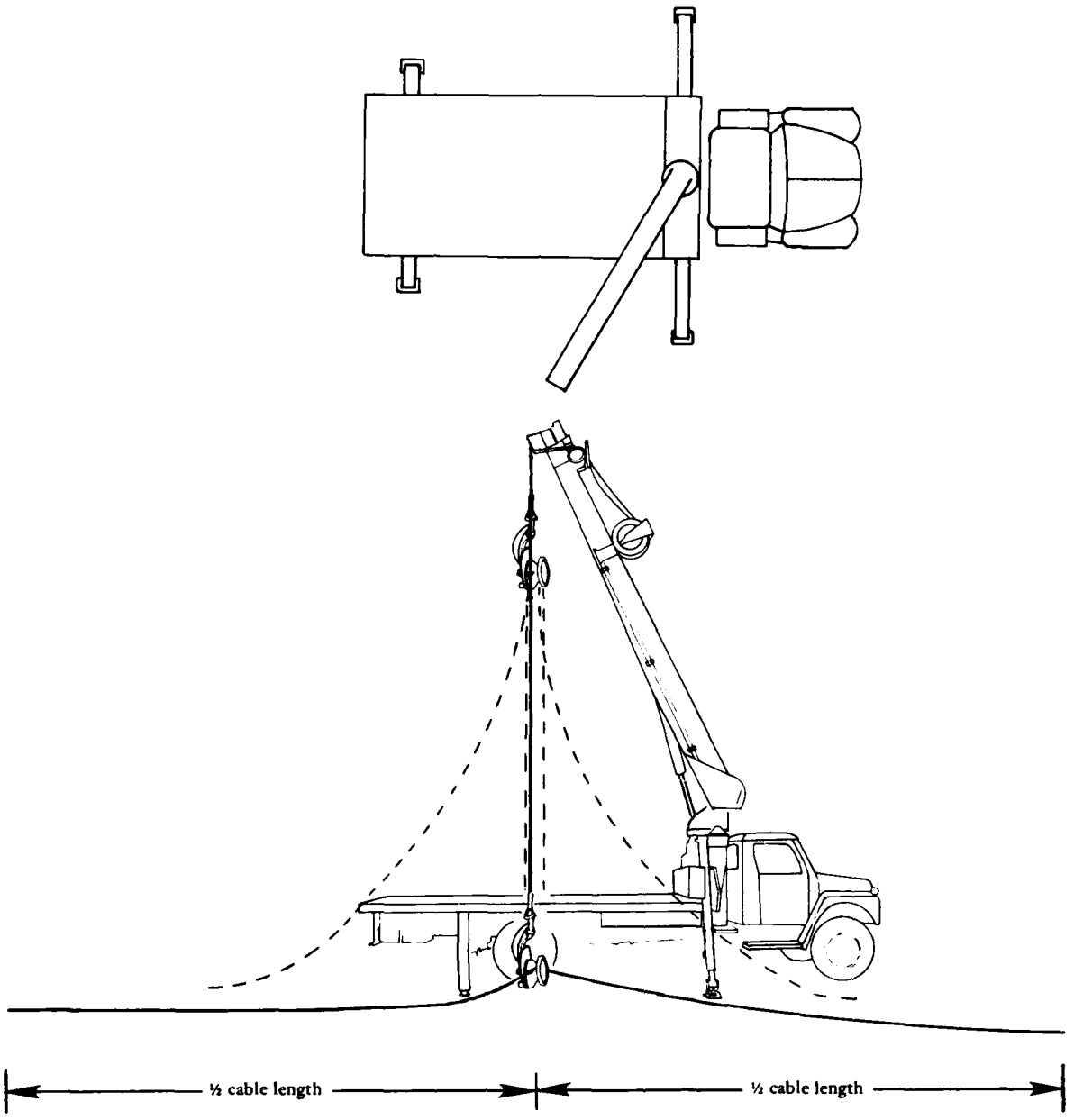


Figure 7-9. Picking up cables from pier (prior to loading on truck).

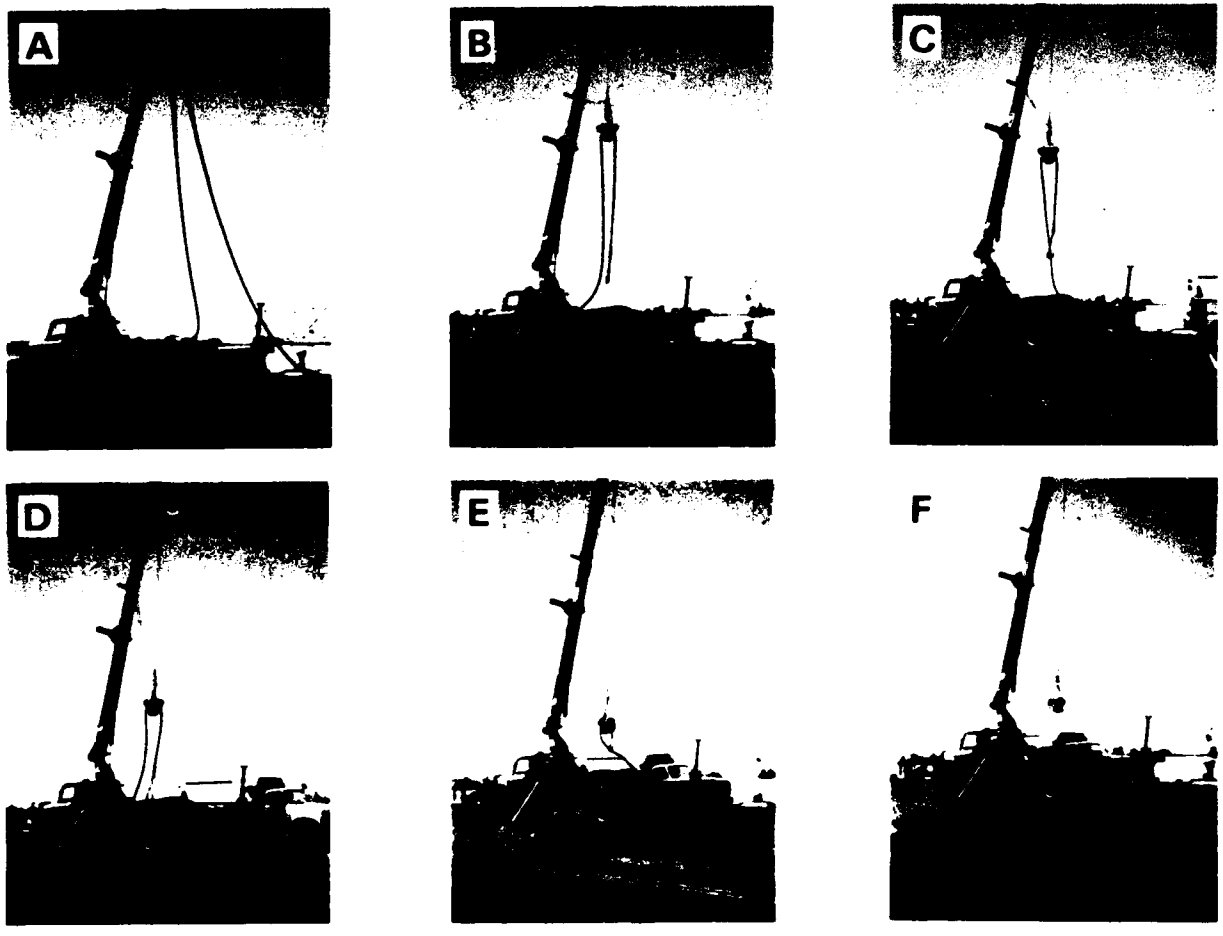


Figure 7-10. Shore power cable handling equipment removing cables from pier after ship departure.

7. Rotate the boom over the truck bed and feed the hanging end of the cable down to the truck bed. Stop the cable just above the truck bed and adjust the boom position to load the cable where desired on the truck bed.

8. Continuously feed cable onto the truck bed. A 6-foot-diameter coil of cable will be formed automatically. Periodically monitor the remainder of the cable on the ground to insure it will not bind on obstructions.

9. When the opposite cable end is pulled aboard the truck bed, lower the power block while continuously feeding cable to avoid dropping the cable. Slow down operation as the block and cable near the truck bed.

10. Stop the power block approximately 2 feet above the coil of cable and slowly feed the cable end onto the coiled pile. No personnel assistance is needed.

11. Repeat steps 3 through 9 for the remaining cables.

12. Return the boom to its traveling position.

13. Retract the outriggers.

Truck cable capacity ranges from 1,000 to 1,500 feet of cable depending on how the cable is coiled on the truck bed. The operator can control cable and coil size by moving the boom periodically and adjusting the power block height above the truck bed.

Before transporting the cables to the storage facility, inspect the cables to prevent cable ends from falling while moving the vehicle. The driver should monitor the cables periodically in mirrors while driving to storage.

7.2.5 Coiling Cables on Pallets. Coiling cables on pallets at the storage facility, like most operations, requires three personnel. Pallets used shall be of standard construction (usually wood) with minimum outside dimensions of 4 by 4 feet. Forklift forks provide a convenient, adjustable height platform on which to coil cables (see Figure 7-11). During coiling ground personnel should inspect the cable jacket as it is handled. If cable damage is found, stop the coiling and mark the damaged area with small twine, strips of rags, or anything to provide easy identification after the cable is set aside for repairs. Coiling is best performed on 125-foot cable lengths plus or minus a few feet. Cable lengths of 150 feet or longer are best coiled on reels with reeling equipment used in conjunction with a cable handling boom truck. The coiling technique is illustrated in Figure 7-11 and cable layout on the pallet is shown in Figure 7-12.

The cable coiling sequence is as follows:

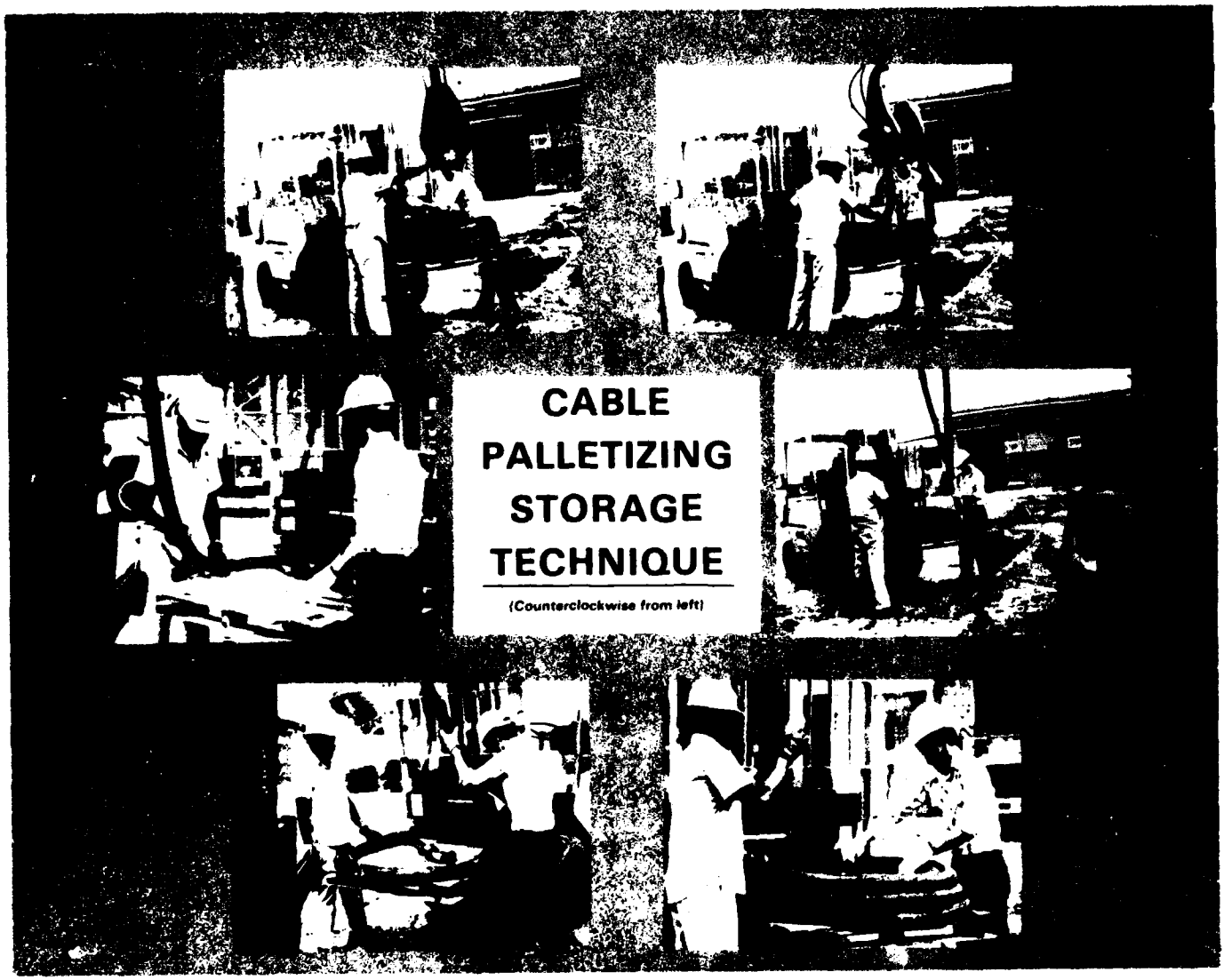
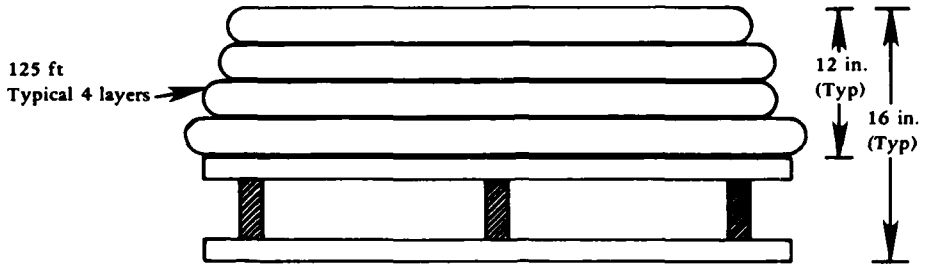


Figure 7-11. Cable palletizing storage technique.



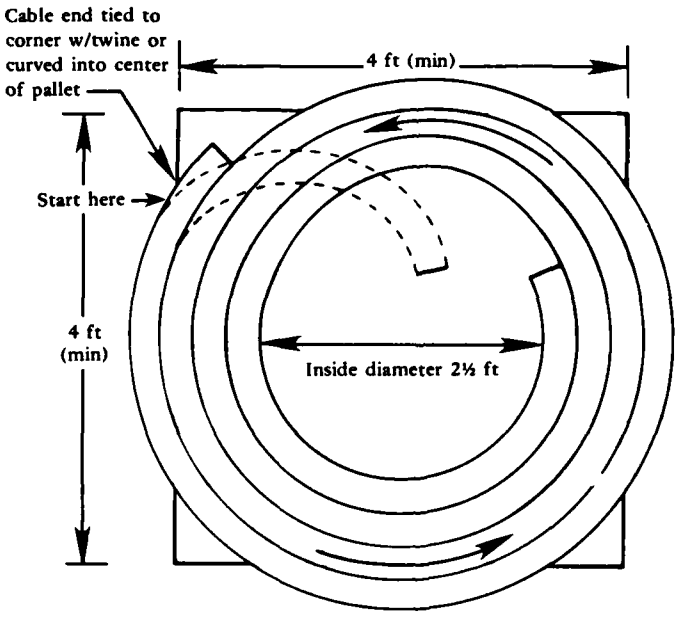


Figure 7-12. Cable layout on pallet.

1. Position the truck as required at the storage facility.

2. Set outriggers.

3. Raise the boom and lower the power block to pick up the first cable on the truck bed.

4. With 6 to 8 feet of cable hanging over the block, raise the block and swing the boom over the pallet.

Note: If in-line connections are used, it is best to have pier end connectors (usually male) placed on the pallet first, since ship end connectors can be fed from the cable on the truck directly to the ship during cable rigging. If the wrong end is available after step 4 above, swing the boom away from the pallet and coil the cable onto the ground and resume operation as in step 4.

5. With the power block approximately 15 to 20 feet above the pallet, feed the cable to lower the cable end to the pallet.

6. Adjust the boom as required to position the cable end near the center of the pallet.

7. Ground personnel will attach or lay the cable on the pallet as shown in Figure 7-11.

8. The first loop of the cable should extend about 6 inches over the edges of the pallet to create a 5-foot-diam circle (on a 4- by 4-foot pallet).

9. Continuously loop the cable inside the previous circle, making four or five concentric loops, then reverse the sequence, piling circles directly over the bottom layer.

10. The operator should constantly warn ground personnel about the opposite end of the cable, particularly if on the truck bed since the cable end will swing and possibly strike personnel.

11. The operator shall lower the block near the end of the cable and maintain the cable end just above the ground personnel. Slowing down operation here is essential.

12. The last 3 or 4 feet of cable can be dropped on the coil with ground personnel standing clear or one person holding the block and the other handing the cable onto the coil.

13. Repeat steps 3 through 12 for each cable.

Cables should be stored in a dry, weatherproof location. If warehouse-type pallet racks are unavailable, pallets can be stacked three high for storage.

Cables in need of repair (i.e., jacket damaged or connector broken) should be tagged and placed in a location to await maintenance.

7.2.6 Cable Rigging Assistance for Ship Connects and Disconnects.

7.2.6.1 Pier Site Selection for Equipment. The most important consideration to perform efficient shore-to-ship cable installation and removal operations is the position of the boom truck on the pier. The following factors should be considered in selecting the location for operating equipment:

- maximum operator visibility of cable and personnel throughout operations
- position relative to ship hull obstructions, antenna, halyards, or other apparatus that could interfere with safe cable handling operations
- equipment out of designated pier fire lanes
- minimize side loading of boom if cable pulling required (i.e., cables on pier need to be moved along pier edge to make connections)
- where excess cable (after ship connection) is laid on pier

Figure 7-13 provides general guidelines for truck site selection and dimensions of pier space required. A sample of site selection is provided in Figure 7-14 for CGN-38 class cruisers.

7.2.6.2 Ship Characteristics. Each ship class possesses unique characteristics that affect cable installation and removal between the pier and ship. Ship electrical interface characteristics include:

- the electrical load (i.e., the number of cables)
- height above pier where cables go aboard the ship
- frame location (position from bow to stern) where cables go aboard ship
- length of cable required from edge of ship deck to shore power station
- whether lifelines are removable where cable is installed (i.e., cables are rigged under permanent railings)

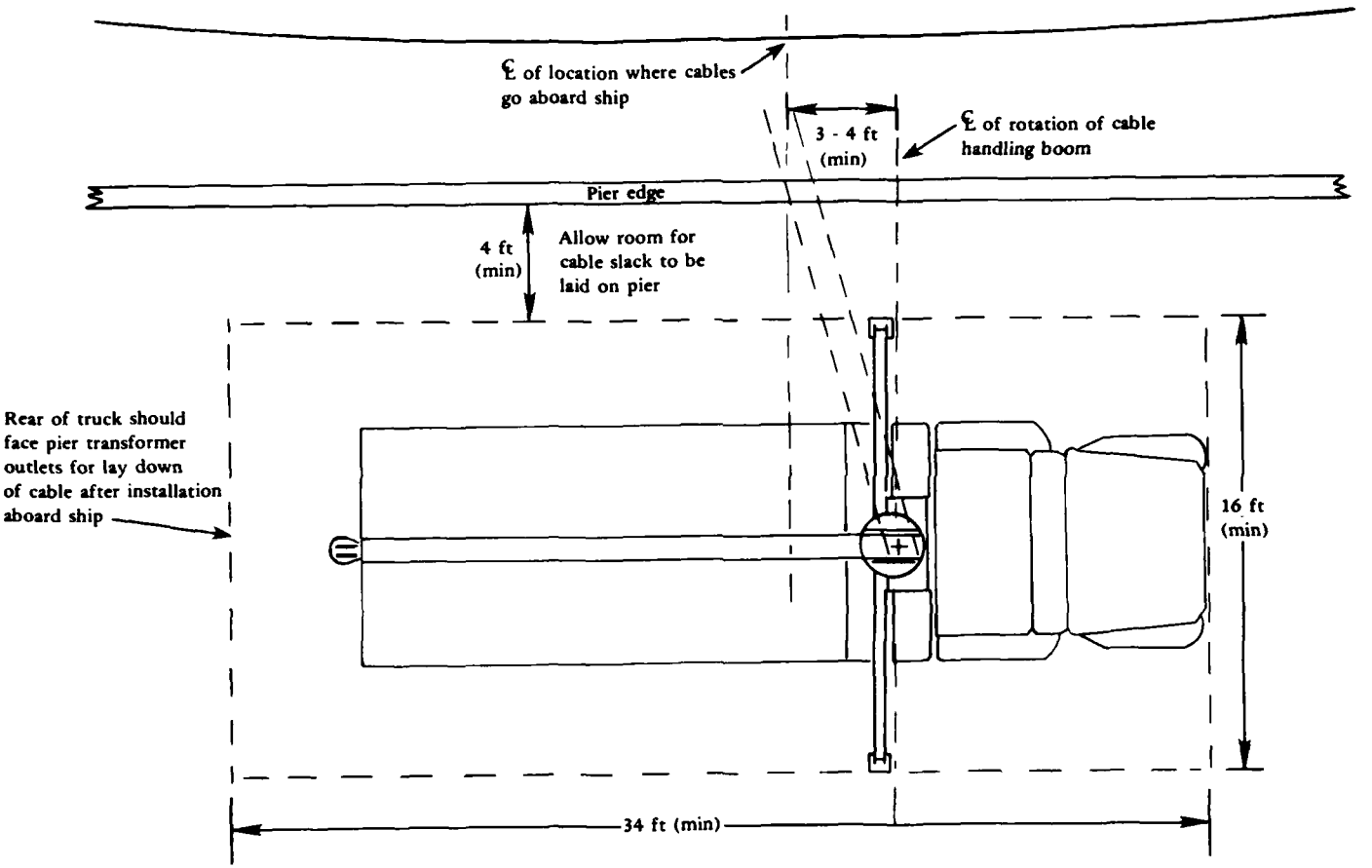


Figure 7-13. Cable handling boom truck pier space and site selection requirements.

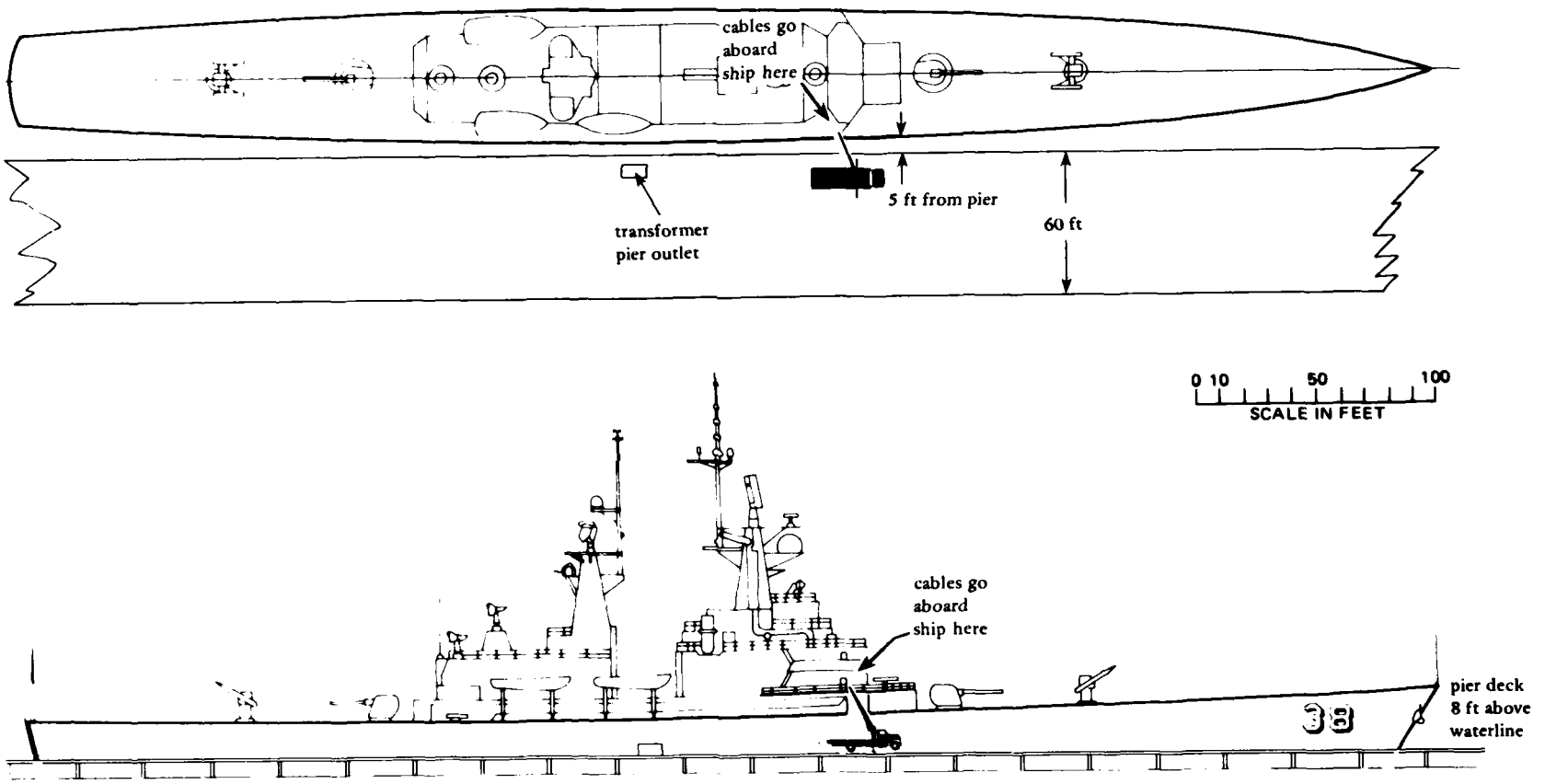


Figure 7-14. Cable handling boom truck operating site selection for CGN-38 class cruisers. (Typical example)

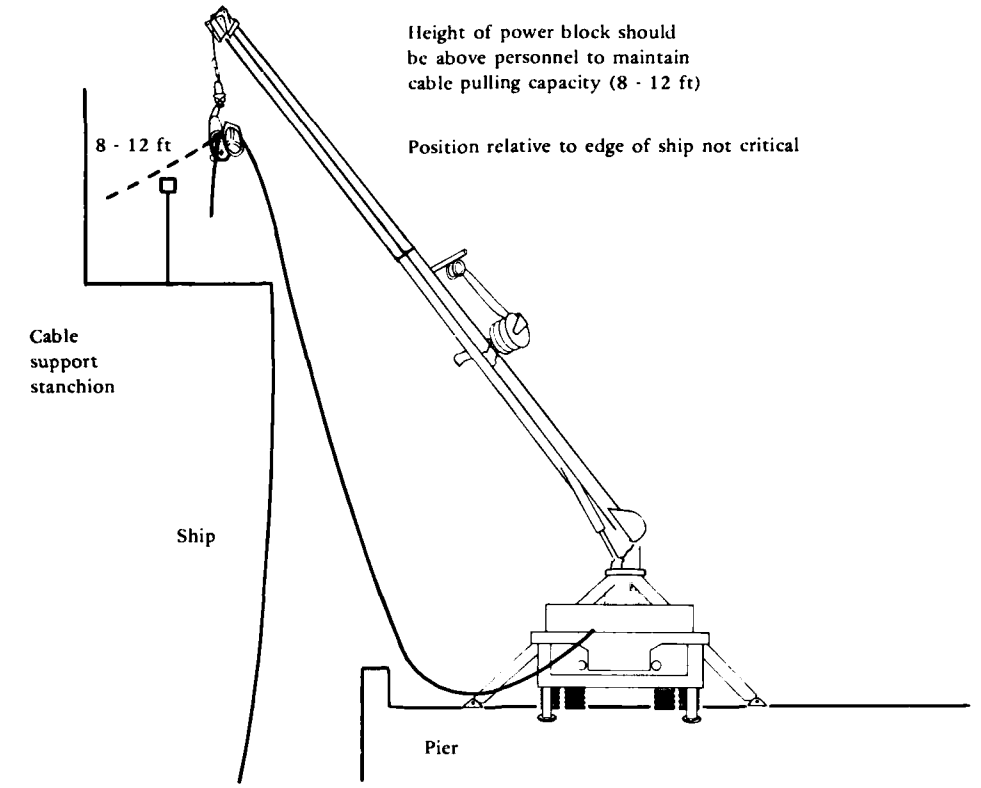
- whether the ship carries its own cable (i.e., will cable reach pier electrical outlets)
- amount of access or room for ship personnel where cables are rigged
- whether ship provides equipment or hardware to support cable above personnel thruways or sharp deck edge coamings (i.e., cable support stanchions)
- ship obstructions that limit available operating space for hydraulic boom and power block (i.e., flight deck of carriers)

The electrical loads and location where cables go aboard ship are provided in the latest edition of NAVFAC Design Manual DM-25, Table 3-4, "Shore Electrical Service." Knowledge of the remaining interface characteristics is best acquired through actual experience in the field while providing electrical shore power services to berthed ships.

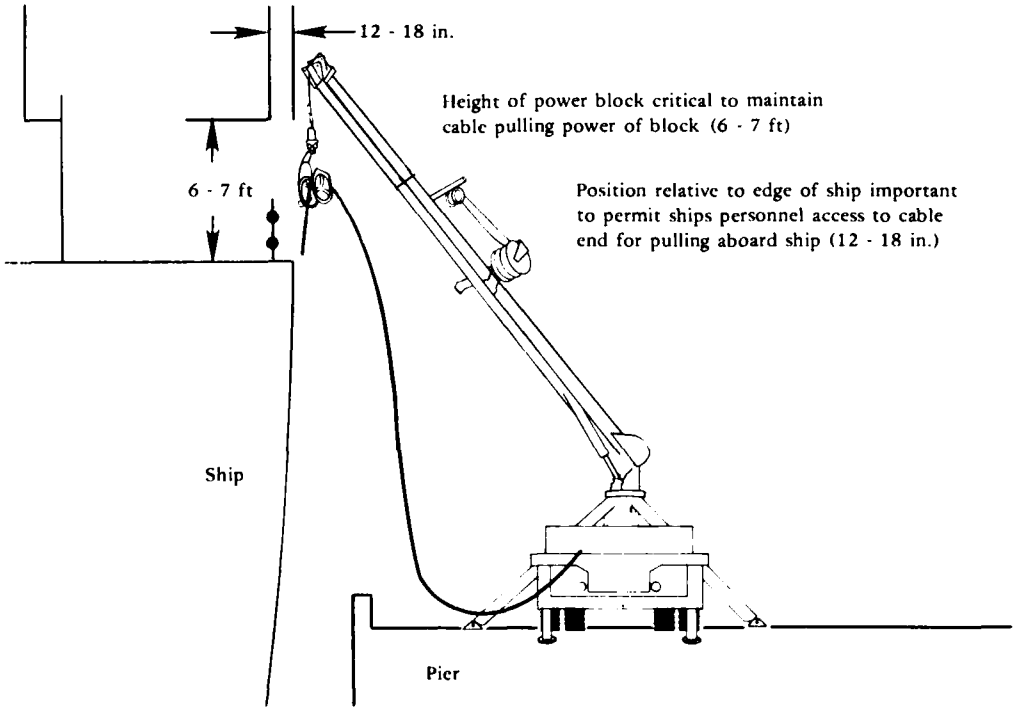
Permanent lifelines or deck edge railings mounted where cables are installed provide the greatest difficulty for cable handling boom truck operators. Cables are normally installed through a 12- by 36-inch opening between the railing and deck edge. Positioning the power block to deliver the ship cable end to ship's personnel and then feed cable aboard the vessel is critical and must be learned through practice. Figure 7-15 provides guidance to positioning the power block for electrical hookups to ships with permanent lifelines and compares it with hookups to ships where removable lifelines or cable support hardware are provided.

7.2.6.3 Shore-to-Ship Cable Installation Procedure. Figure 7-16 illustrates a typical sequence of events to provide cable installation service to a berthed ship. The general procedure for shore-to-ship cable installation is as follows:

1. Install cables, as required, on pier prior to ship arrival (see Section 7.2.3).
2. Load cables on boom truck approximately 30 minutes prior to ship arrival.
3. Transport cables and boom truck to assigned berth for ship arrival.
4. Position truck for cable hookup after ship is moored (see Figure 7-13).
5. Set outriggers prior to boom operation.
6. Operate boom to pick up cable off truck bed and elevate to ship cable installation location.

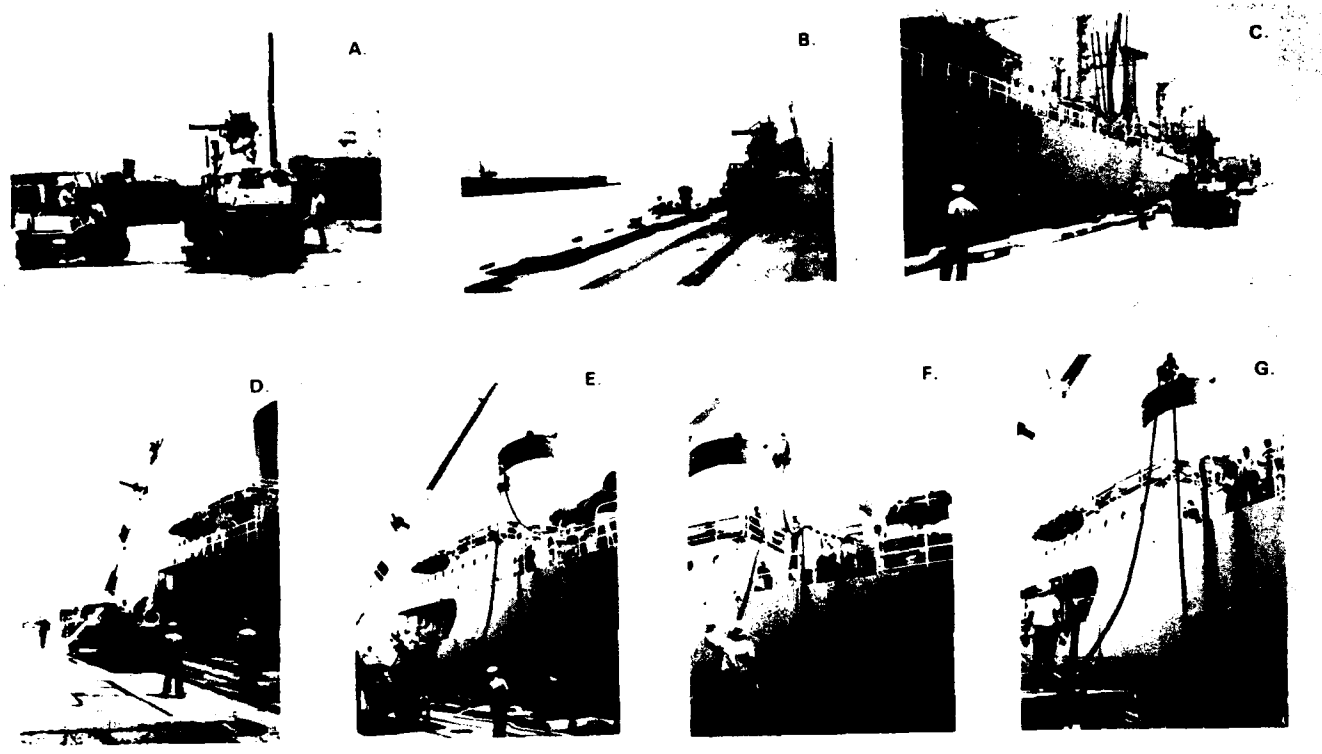


a. Cable installation with removable lifelines or cable support hardware.



b. Cable installation with permanent lifelines.

Figure 7-15. Power block position for cable installation to ships.



INSTALLATION PROCEDURE SHORE POWER CABLE

A. Palletized cable loaded on truck

B. Truck awaiting ship arrival at pier

C. Ship arrival — Operator selects truck location

D. Boom truck setup – First cable installed in power block

E. Operator pays out enough cable to make ship connection

F. Ships crew positions cable on support structure

G. Operator continuously feeds cable to reach pier

H. Operator swings, lowers boom and lays cable on pier

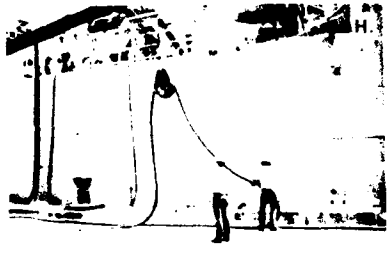


Figure 7-16. Installation procedure shore power cable.

7. Feed cable aboard ship, as required, with ship's personnel assistance (signalman required).

8. Lower excess cable slack to pier by lowering power block and continuously feeding cable.

9. Swing boom while feeding cable to layout excess cable length on pier as required (some assistance from ship's personnel on pier is recommended).

10. Repeat steps 6 through 9 for each cable.

11. Place boom in traveling position.

12. Retract outriggers.

13. Make cable connections, perform electrical system checks, and energize cables in accordance with Standard Operating Procedures (SOP) established by Public Works activity.

Variations of this procedure will occur primarily with ships that carry their own cables. The cable handling boom truck can provide assistance in layout of excess cable on the pier after cable has been lowered to the pier manually by ship personnel.

7.2.6.4 Shore-to-Ship Cable Disconnect Procedure. The general procedure for shore-to-ship cable disconnects is as follows:

1. Transport cable handling boom truck to designated pier for ship departure.

2. Deenergize cables and break cable connections in accordance with Standard Operating Procedures (SOP) established by Public Works activity.

3. Position boom truck to remove cables (see Figure 7-13).

4. Set outriggers prior to operating boom.

5. Operate boom to insert first cable in block for removal from the ship (see Figures 7-17 and 7-18).

6. Raise power block while feeding cable (to maintain slack) to a position where the power block supports the cable approximately 8 feet above the ship deck.

7. Raise or swing boom to remove cable from the ship to a position over the pier. (Note: 6-8 feet of cable must hang over the block before cable is removed.)

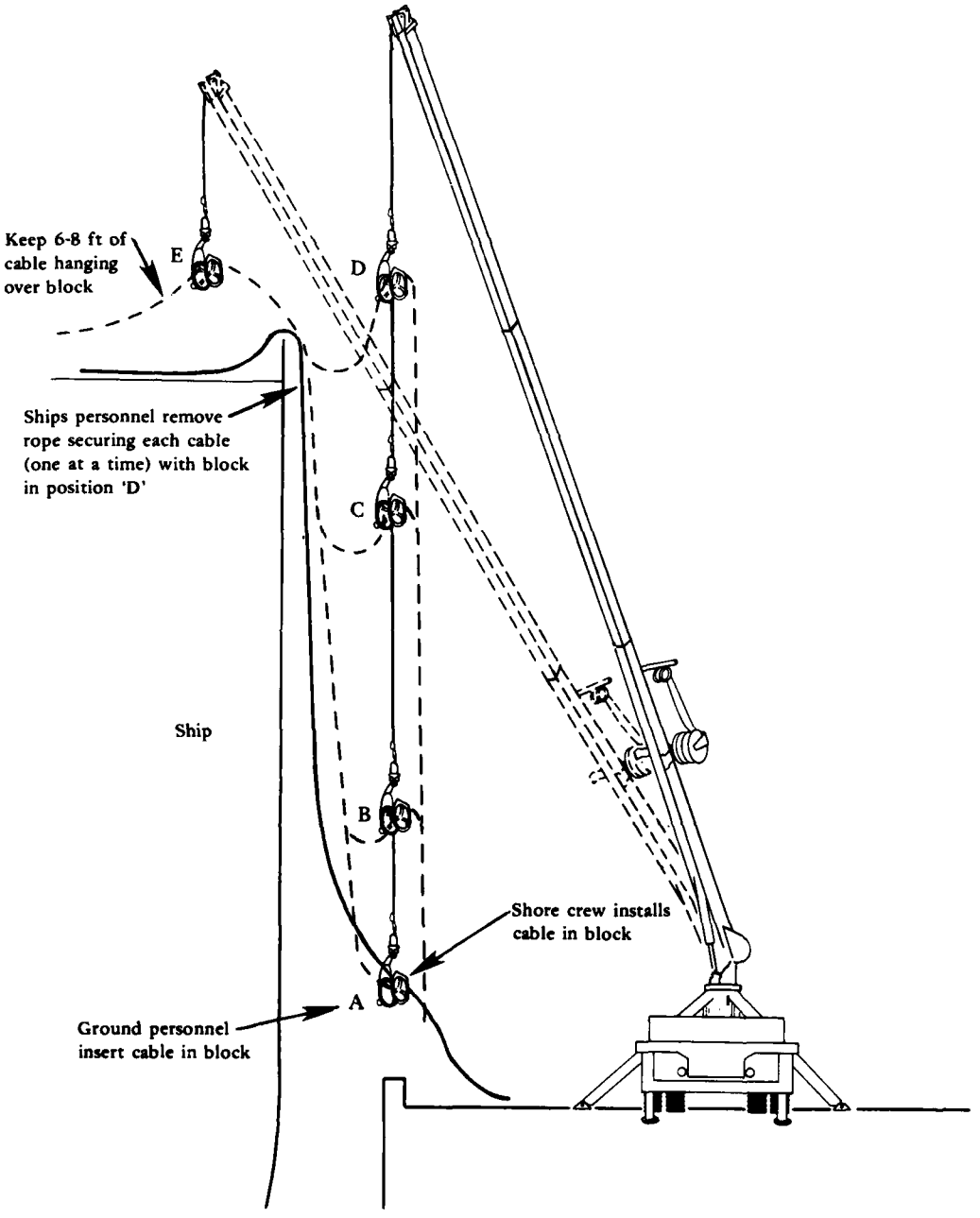


Figure 7-17. Removing cable from ship starting at pier.

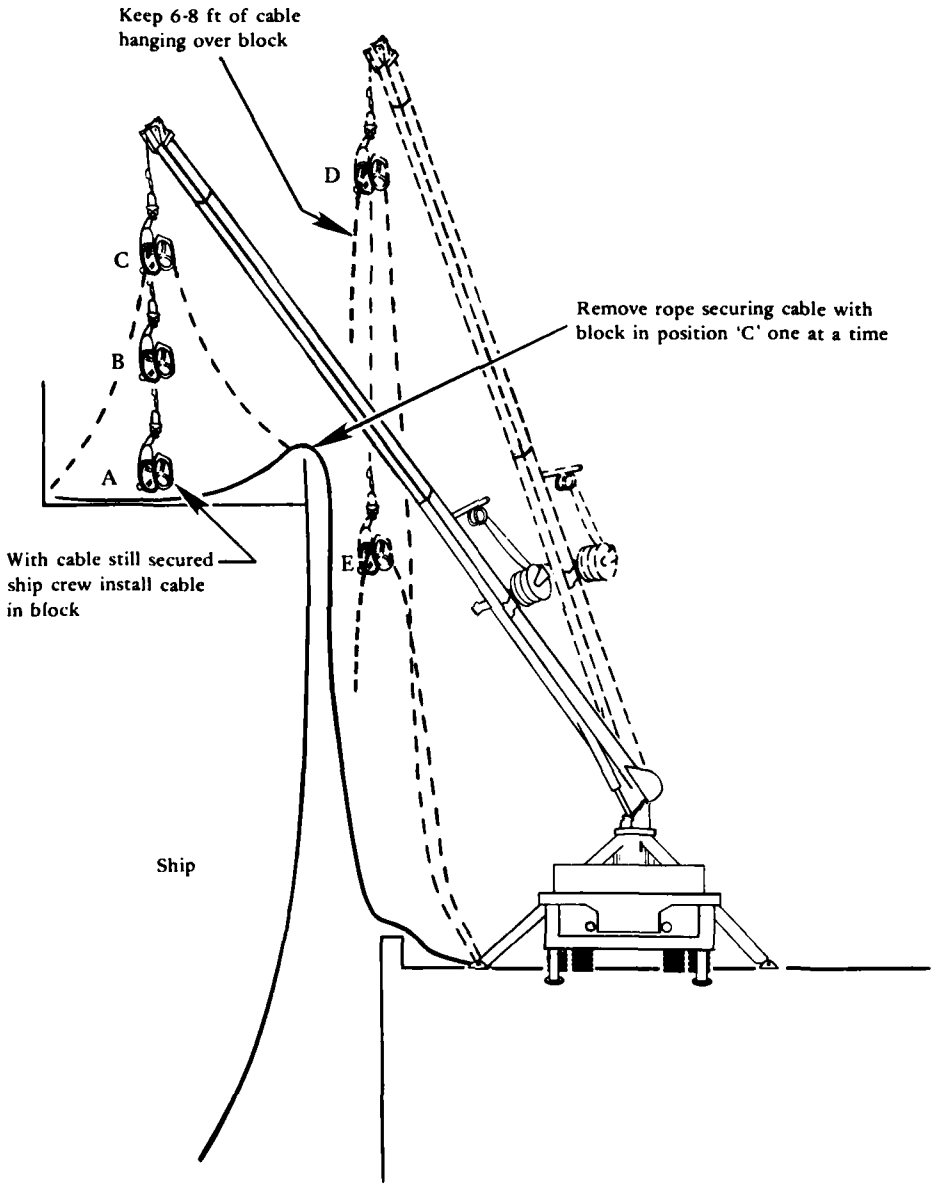


Figure 7-18. Removing cable from ship with cable installed in block aboard ship.

8. Lower the power block and operate the boom as necessary to lay cable on the pier.

9. Repeat steps 5 through 8 for each cable.

10. After all cables are disconnected from the ship, remove the cables from the pier (see Section 7.4.4).

11. Transport cables to storage facility and coil cables on pallets for storage and/or maintenance (see Section 7.4.5).

For ships that carry their own cables, steps 7 and 8 of the above procedure will change as follows:

7. Operate power block to feed cable aboard ship as directed by ship personnel (signalman required).

8. As cable end from pier approaches power block, lower power block to a position 2 or 3 feet above ship deck.

7.2.6.5 Special Cases for Ship Connects and Disconnects. Aircraft carriers (CV's and CVN's) and LHA's (aft station only) limit the vertical operating range of the cable handling boom because the flight deck structure is 4 to 5 feet above the shore power stations. For these ships, it is recommended that the ship crew provide a rope to be used as a tagline to pull the cable end into the cable installation area. Cable slack must be maintained between the power block and cable installation area to effectively power feed cable (see Figure 7-19).

7.2.6.6 Cable Installations to Various Ship Classes.

Figure 7-20. AO-177 class.

Figure 7-21. CG-16 class.

Figure 7-22. CG-47 class.

Figure 7-23. CGN-38 class.

Figure 7-24. CV-67 class.

Figure 7-25. DD-963 class.

Figure 7-26. DDG-993 class.

Figure 7-27. LPH-2 class.

Figure 7-28. Nested CGN-38 class outboard CG-16 class.

Figure 7-29. Nested DD-963 class outboard DD-963 class.

7.2.5 Nested Ship Deck Edge Rollers. The cable handling boom truck does provide a significant improvement in the time and manpower to rig cables to nested ships. However, as shown in Figure 7-29(b), several personnel are required to haul cable aboard the nested ship. A large amount of pulling force is required to overcome friction between the rubber jacketed cable and the metal deck and deck edges of the ship. It is recommended that a few portable deck edge rollers be fabricated (see Figure 7-30) by Public Works activities to demonstrate the benefits achievable in Fleet manpower savings and particularly in reduced wear and tear of shore power cables dragged over sharp deck edges. Fabrication sketches are provided in Appendix D.

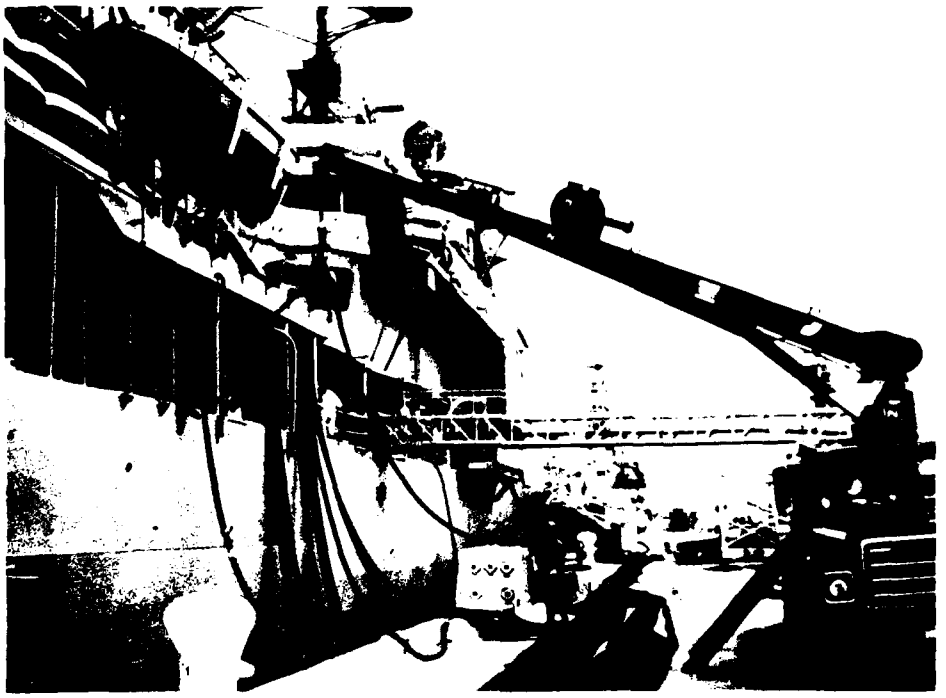
Figure 7-19. Ships personnel provide rope as tagline for aircraft carrier cable connect operation (Note slack between shore power station and power block).

Figure 7-20. Cable installation to AO-177 Class. (AO-186 USS PLATTE)

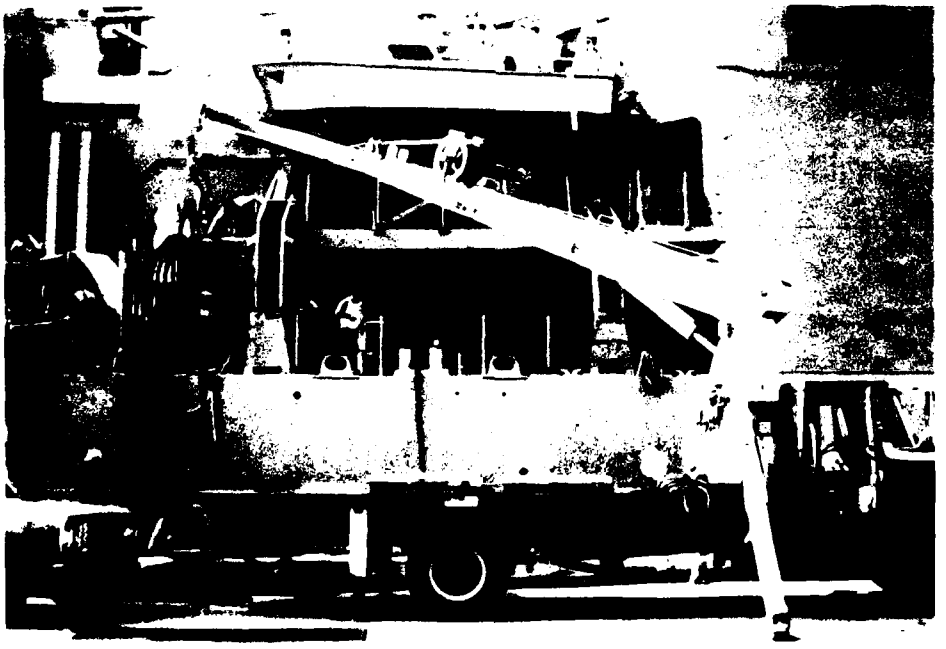
(a) Forward station

(b) Aft station

Figure 7-21. Cable installation to CG-16 Class. (CG-17 USS YARNELL)



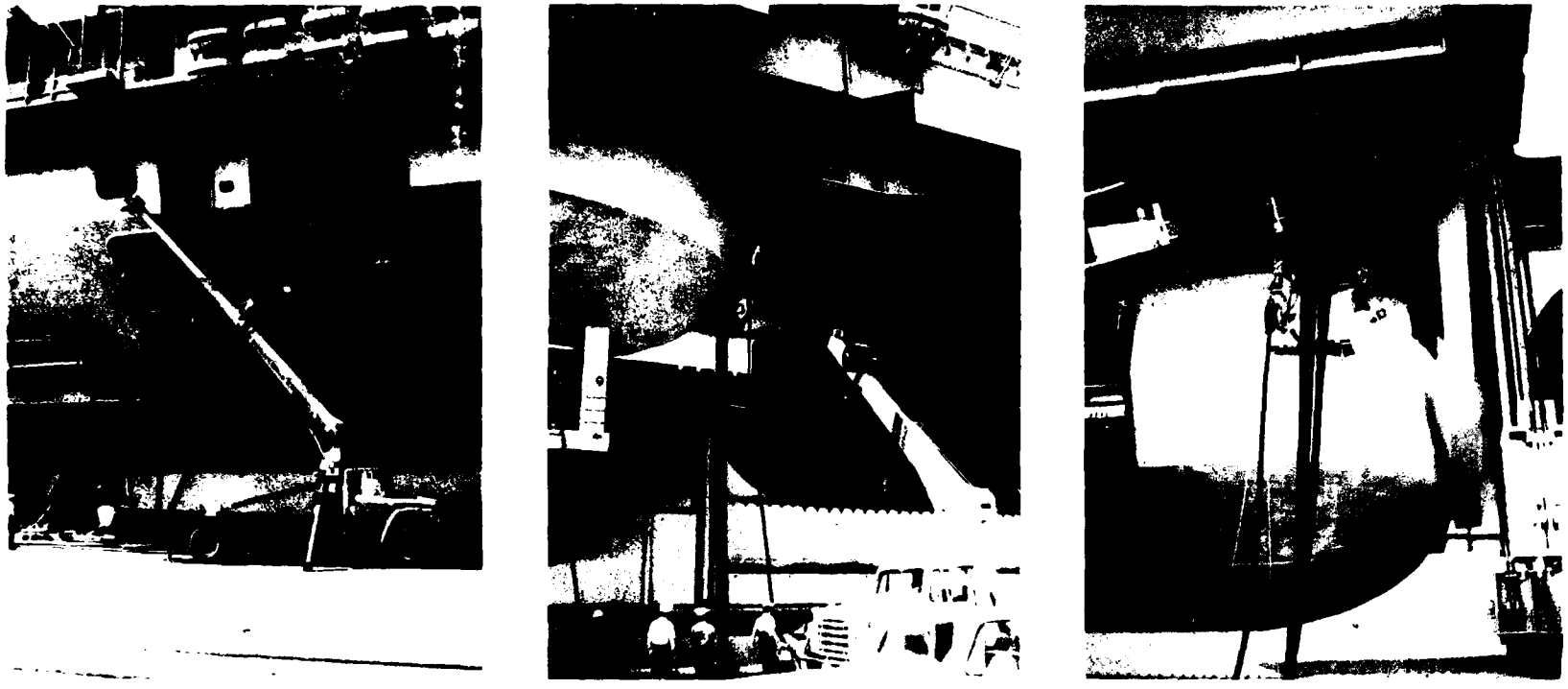
(a) Starboard station



(b) Port station

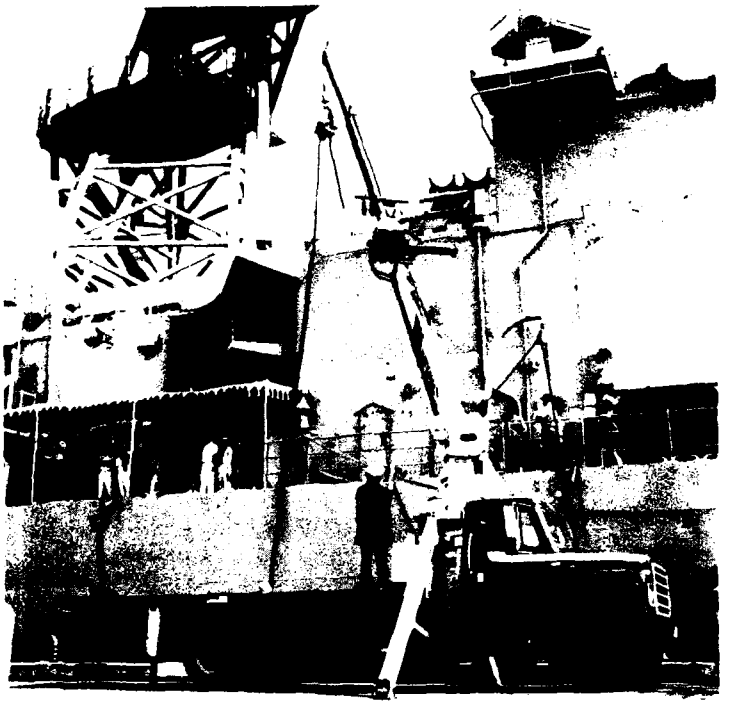
Figure 7-22. Cable installation to CG-47 Class. (CG-47 USS TICONDEROGA)

Figure 7-23. Cable installation to CGN-38 Class. (CGN-40 USS MISSISSIPPI)

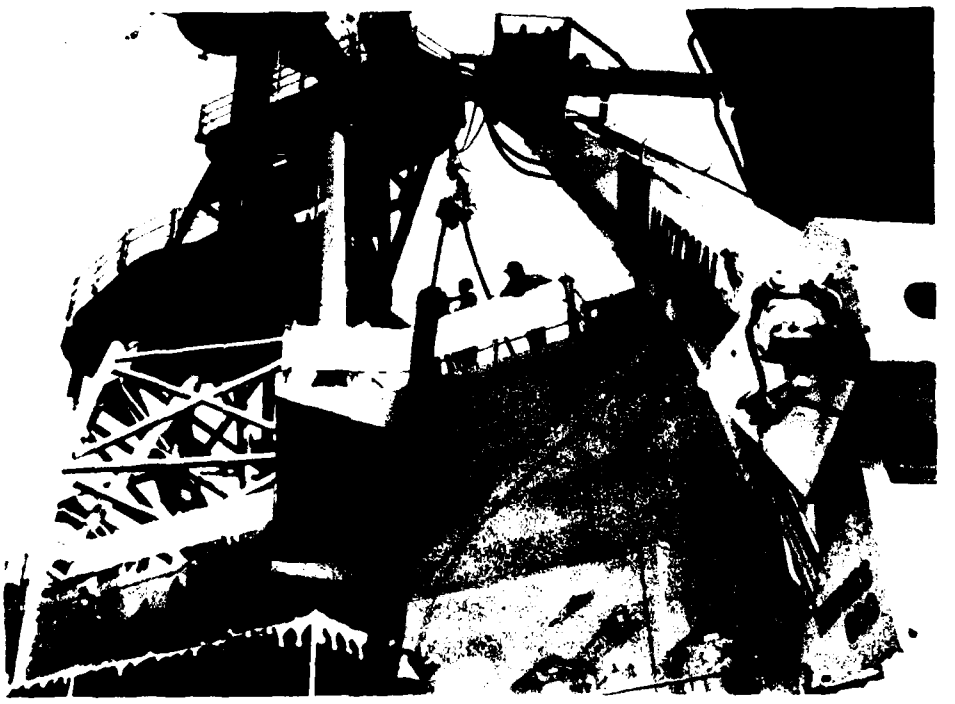


(a) (b) (c)

Figure 7-24. Cable installation to CV-67 Class. (CV-67 USS JOHN F. KENNEDY)



(a)



(b)

Figure 7-25. Cable installation to DD-963 Class. (DD 978 USS STUMP)

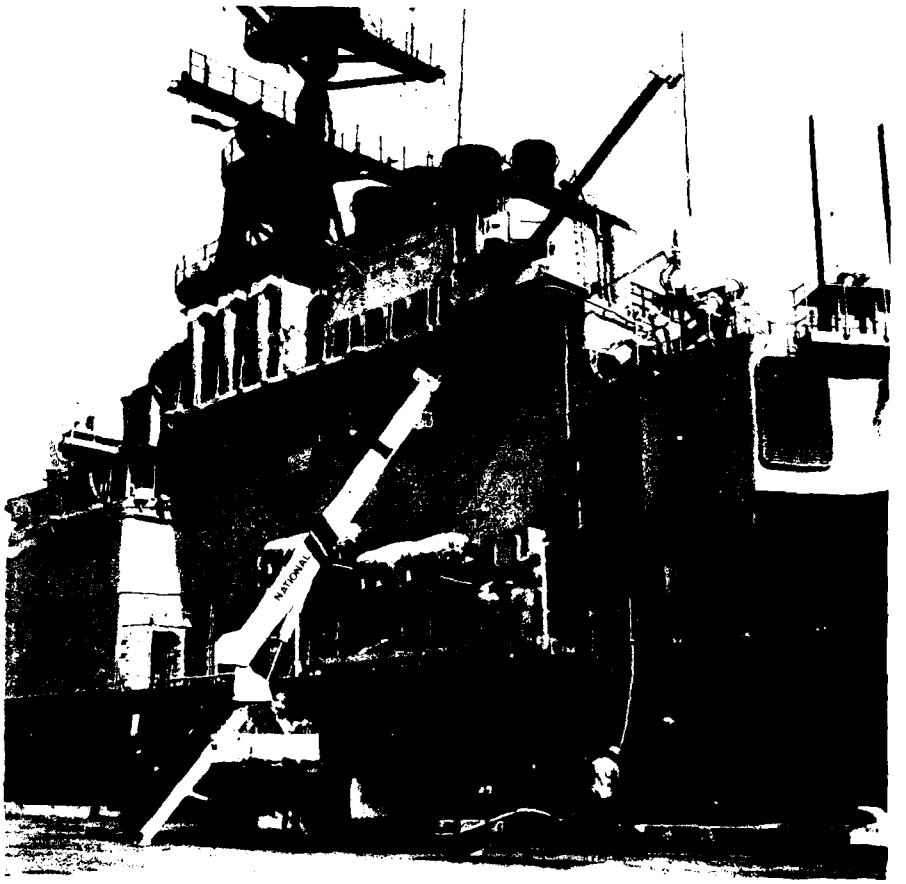
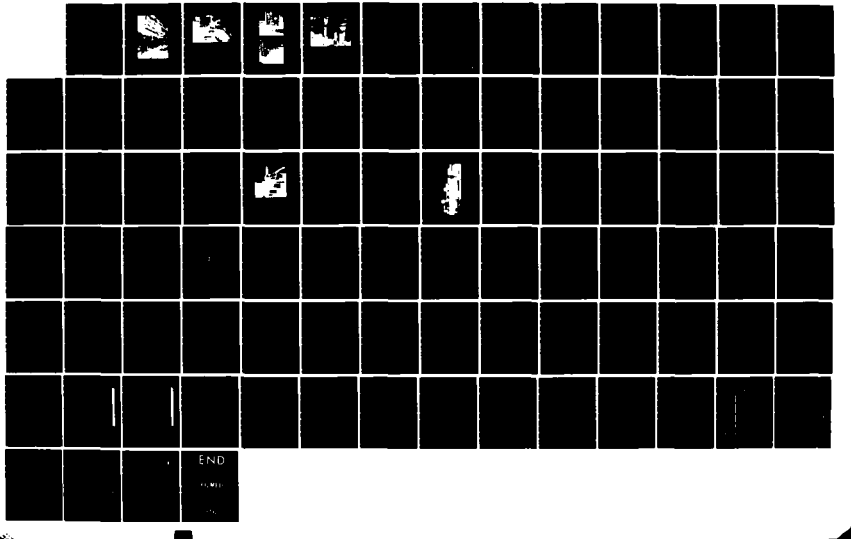


Figure 7-26. Cable installation to DDG-993 Class. (DDG-993 USS KIDD)

AD-A150 416 USER DATA PACKAGE SHORE-TO-SHIP ELECTRICAL POWER CABLE HANDLING EQUIPMENT(U) NAVAL CIVIL ENGINEERING LAB PORT HUENEME CA D E DAHLE JAN 85 NCEL-TN-1718 2/2

UNCLASSIFIED F/G 10/2 NL



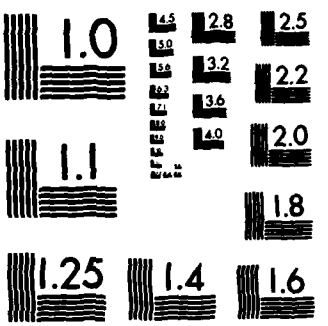


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Figure 7-27. Cable installation to LPH-2 Class. (LPH-9 USS GUAM)

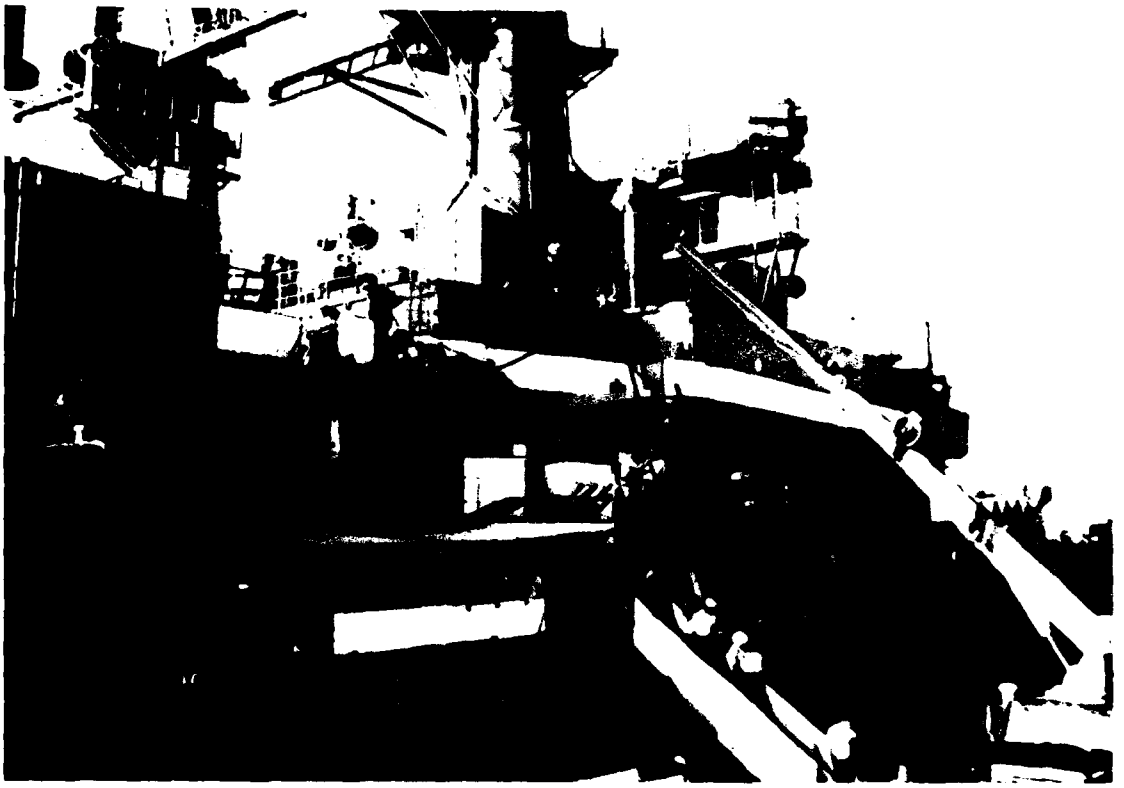
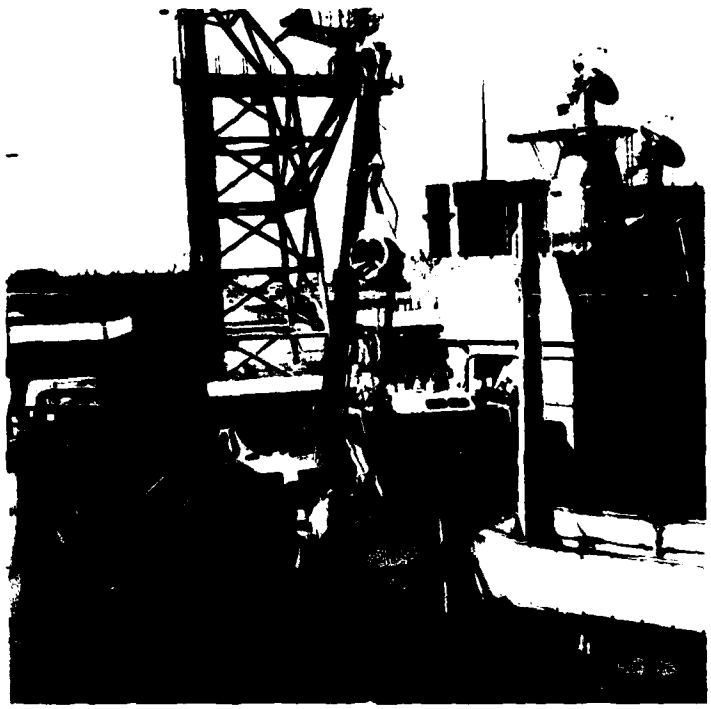
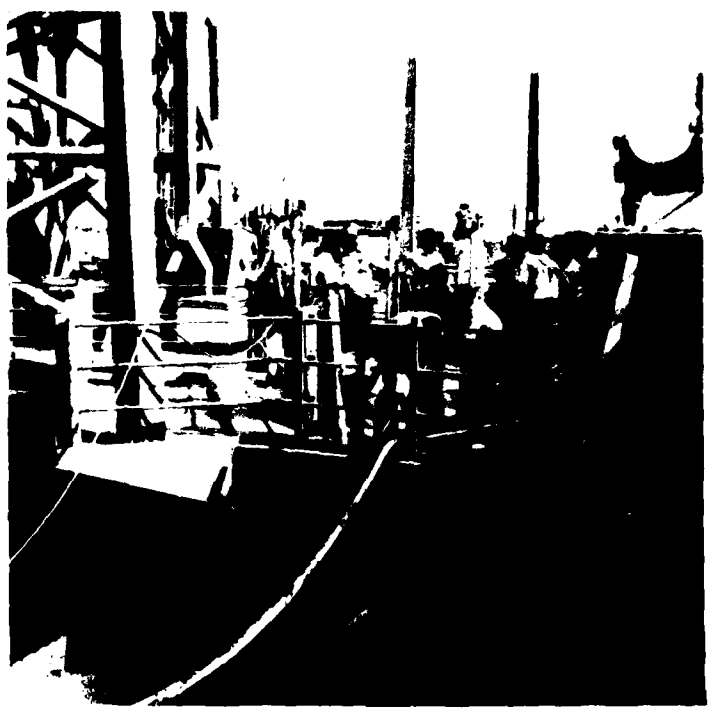


Figure 7-28. Cable installation to CGN-36 Class (CGN-36 USS CALIFORNIA) Nested Outboard CG-16 Class (CG-17 USS YARNELL).



(a) View from inboard ship toward pier



(b) View from inboard ship toward outboard ship

Figure 7-29. Cable installation to DD 963 Class (DD-977 USS BRISCOE) Nested Outboard DD-963 Class (DD-978 USS STUMP)

Figure 7-30. Prototype portable deck edge roller for nested ship cable handling (expected to reduce manpower and cable damage during rigging - see Figure 7-29).

Appendix A

DRAFT SPECIFICATION
TRUCK, CABLE HANDLING, BOOM

CONTENTS

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DRAFT SPECIFICATION
TRUCK, CABLE HANDLING, BOOM

1.0 SCOPE

1.1 This specification covers a diesel-engine-driven, four-wheel, two-rear wheel drive (4X2), cab and chassis with stake body, having a minimum gross vehicle weight (GVW) of 39,000 pounds (lb), equipped with a three-section, telescoping, hydraulic boom, center-mounted behind the cab on chassis frame for mounting specialized attachments for handling three-conductor, electrical shore power cables to service berthed NAVY vessels. Vehicles procured under this purchase description are commercial items which shall be warranted by the manufacturer as specified in procurement documents.

2.0 APPLICABLE DOCUMENTS

2.1 Government Documents.

2.1.1 Specifications and Standards. Unless otherwise specified, the following specifications and standards of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation, form a part of this purchase specification to the extent specified herein.

STANDARDS

FEDERAL

FED-STD-595 - Colors.

MILITARY

MIL-STD-1223 - Administrative Wheeled Vehicles Treatment, Painting, Rustproofing, Undercoating, Identification Marking, and Data Plates.

(Copies of specifications and standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.1.2 Other Government Documents, Drawings, and Publications. The following other Government documents form a part of the purchase description to the extent specified herein.

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DEPARTMENT OF TRANSPORTATION (DoT)

Federal Motor Vehicle Safety Standards and Regulations.
Federal Motor Carrier Safety Regulations.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, DC 20402.)

ENVIRONMENTAL PROTECTION AGENCY

Control of Air Pollution from the Motor Vehicles and New Motor Vehicle Engines.

Noise Emission Standards for Transportation Equipment - Medium and Heavy Trucks.

(Application for copies should be addressed to the Public Affairs Office, Environmental Protection Agency, Rockville, MD 20852.)

2.2 Other Publications. The following documents form a part of this purchase specification to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI)

ANSI B30.5 - 1982. Mobile and Locomotive Cranes

(Applications for copies should be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.)

SOCIETY OF AUTOMOTIVE ENGINEERS, INC. (SAE)

SAE Handbook.

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.)

TIRE AND RIM ASSOCIATION, INC.

T&RA Yearbook

(Application for copies should be addressed to the Tire and Rim Association, Inc., 3200 West Market, Akron, OH 44313.)

2.3 Order of Precedence. In the event of a conflict between the text of this purchase description and the reference cited herein, the text of this purchase description shall take precedence.

3.0 REQUIREMENTS

3.1 Standard Vehicle and Accessories. Except as specified herein, the vehicle, components, assemblies, and accessories to be delivered under the contract, shall be standard or optional items which meet or exceed the requirements of this purchase specification. Chassis items shall be as represented in the chassis manufacturer's technical data and the body and mounted equipment shall be as represented in the body and the equipment manufacturer's technical material, identical to that furnished to the authorized company representatives for selection of the vehicle models and components.

3.1.1 Special Requirements. In addition to standard vehicle and components specified in 3.1, vehicle shall be furnished in accordance with the special requirements as specified herein.

3.1.1.1 Exterior Painting and Marking. Treatment, painting, identification markings, and data plates shall be in accordance with MIL-STD-1223 as specified for the Navy, except exterior shall be painted as follows:

a. Cab, body,and mounted equipment shall be painted safety yellow to match color chip No. 13538 of FED-STD-595. Stake body front, side, and rear rails shall be painted black with manufacturer's standard exterior paint. Step type rear bumper shall be painted with the same exterior color as for the cab above.

b. The Navy registration markings on cab doors and rear of body shall be black as specified in MIL-STD-1223.

3.1.1 2 Rustproofing. Vehicles shall be rustproofed as specified in MIL-STD-1223. In addition, rustproofing material shall be applied using an atomized spray to all surfaces at the following areas:

a. Chassis frame members and chassis cross members.

b. All exposed areas under the vehicle.

3.1.1.3 Drain Plugs. Drain plugs installed in rear axle shall be of the permanent magnet type.

3.1.1.4 Heavy Duty Cooling System. A heavy duty cooling system shall be furnished that will maintain engine coolant at a temperature below the boiling point with the vehicle loaded to rated GVW and operated at an altitude of 10,000 feet above sea level or in an ambient air temperature of not less than 125 degrees Fahrenheit (°F).

3.1.1.5 Coolant System. The coolant system shall include a surge tank or a coolant recovery reservoir of not less than two quart capacity.

3.1.1.6 Wood Treatment. Wood flooring of stake body platform (see paragraph 3.5.3.4) shall be cleaned and treated with two coats high quality sealer or preservative to protect wood from exposure to the

atmosphere. When practicable, the wood parts shall be cut to final dimensions, and boring and shaping operations shall be completed prior to treatment in accordance with MIL-STD-1223.

3.1.1.7 Towing Devices. Not less than four hooks, loops, or pins, for towing vehicle shall be furnished, two on front and two at rear of the vehicle

3.1.1.8 Wheel Splash and Stone Throw Protection. All splash shield and mud flap installations, front and rear, shall conform to the rear splash and stone throw protection provisions of SAE J682. All tilt cabs, if provided, shall have rubber mud flaps to the rear of the front wheels.

3.2 General Design.

3.2.1 Federal Motor Vehicle Safety Standards. The vehicle and furnished accessories shall comply with all Federal Motor Vehicle Safety Standards in effect on the date of manufacture.

3.2.2 Air Pollution Control. The vehicle shall comply with the Environmental Protection Agency Regulations governing control of air pollution from new motor vehicles and new motor vehicle engines in effect on the date of manufacture. In addition, vehicles destined for California shall comply with State of California regulations governing air pollution control in effect on the date of manufacture.

3.2.3 Sound Level. The interior sound level shall conform to Federal Motor Carrier Safety Regulation 393.94. The vehicle exterior sound level shall conform to the Environmental Protection Agency Noise Emission Standards for Transportation Equipment, Medium and Heavy Trucks.

3.2.4 Curb Weight. Curb weight shall include weight of chassis and cab, with all attachments, accessories, and equipment as specified herein; and full complement of fuel, lubricants, and coolant.

3.2.5 Payload. The payload shall consist of two people whose individual weight shall be computed at 175 pounds each and a payload of 1,0000 lbs, which shall be computed as being equally distributed over the platform area at the vehicle. Normal operating speed range for axle and tire rating with the above payload shall be 21-30 mph.

3.2.6 Gross Vehicle Weight. Gross vehicle weight (GVW) shall include the curb weight and the payload. GVW shall be 39,000 pounds minimum.

3.2.7 Specified GAWR. The gross axle weight rating (GAWR) shall be not less than 16,000 lbs on the front and 23,000 pounds on the rear.

3.2.8 Ratings. Vehicle ratings shall be the manufacturer's published ratings. Component and vehicular ratings shall not be raised to meet the requirements of this specification. When published ratings are not available, verification of ratings must be submitted to the engineering office of the procuring activity.

3.2.9 Wheel Base. The wheel base shall be not less than 200 inches.

3.2.10 Overall Height. The overall height of the unit shall be not greater than 152 inches.

3.2.11 Overall Width. The overall width of the vehicle, exclusive of mirrors, lights, reflectors, and tires, shall be not more than 96 inches.

3.3 Performance.

3.3.1 Speeds and Gradeability. High and low speed requirements shall be met with truck loaded to specified GVW.

3.3.1.1 High Speed Gradeability. The vehicle shall ascend continuous grade of one percent at 50 miles per hour (mph). Gradeability requirements shall be met with the main transmission in direct drive, and when two-speed axle is furnished, with the axle in high speed range. Gradeability shall be verified with calculations in accordance with SAE J688.

3.3.1.2 Low Speed. Low speed shall be calculated with the engine operating at not less than 35 percent of recommended governed speed, and shall provide not more than the vehicle speed of 5 mph for four or five forward speeds or three mph for eight or ten forward speeds, if multi-speed rear axle is furnished.

3.3.1.3 Maximum Geared Speed. The maximum geared speed at engine governed speed shall be not less than 60 mph (minus one percent).

3.3.2 Service Brakes. The service brakes shall control and hold the vehicle, when loaded to its specified GVW, on a 30 percent grade. The service brakes shall stop the vehicle, loaded to specified GVW, within the stopping distance requirements of Federal Motor Carrier Safety Regulation 393.52.

3.4 Chassis Components.

3.4.1 Engine. The engine furnished for the specified vehicle class shall be the chassis manufacturer's standard, or optional engine for the commercial model truck which meets or exceeds the requirements of this purchase descriptions. The engine shall be equipped with a liquid cooled, compression ignition, two-stroke or four-stroke cycle diesel engine, with not less than six cylinders. The engine furnished shall produce the required vehicle performance (see paragraph 3.3) when operated at engine speed not more than manufacturer's recommended operating speed. Engine net horsepower figures used in performance prediction calculations shall be determined in accordance with SAE J816. A fan clutch to reduce fan speed automatically, when not required for engine cooling, shall be provided.

3.4.1.1 Oil Filter. A full flow throwaway type oil filter shall be furnished.

3.4.1.2 Radiator Fill Neck. Radiator water fill neck shall be accessible to the operator when standing on the ground surface.

3.4.1.3 Coolant Temperature Control. Thermostatic control of engine coolant temperature shall be provided. For diesel engine, the control shall include partial thermostatic control of coolant flow through the radiator and thermostatically controlled radiator shutters or complete thermostatic control of all coolant flow through the radiator.

3.4.2 Electrical System. The electrical system shall be in accordance with Federal Motor Carrier Safety Regulations 393.27 through 393.31 and 393.33.

3.4.2.1 Starting System. For diesel engine driven vehicles, a 12 or 24-volt starting system, with 12-volt direct current (dc) lighting system shall be furnished. A minimum 60-ampere alternator shall be furnished. Engine starting equipment shall include an ether starting system or glow plug. If an ether system is furnished in lieu of a glow plug, it shall be of the measured shot type. Measured shot type ether systems shall be key operated or manually operated from the driver's compartment, shall have a reservoir or provisions for a reservoir of not less than 12 fluid ounces, and shall be inoperative with the engine warm.

3.4.2 Lighting. All vehicle lights, reflectors, and wiring shall be as specified herein and shall conform to Federal Motor Carrier Safety Regulations 393.12, 393.13, 393.19, 393.20 and 393.22 through 393.26(d). Chassis electrical system shall be 12V dc. Lights and reflectors shall not be mounted on vertical surface of rub rails (unless recessed and fully protected) or mounted on vehicle bumpers. Two backup lights shall be provided (recessed and fully protected) at rear of vehicle.

3.4.2.1 Turn Signals. Turn signal lamps shall conform to SAE J588. Operating units shall conform to SAE J589, Class A, and shall be mounted on the steering column. Turn signal operating units shall have visible and audible flash indicator. Turn signals shall be of the self-canceling type. Rear signal unit shall be recessed and fully protected.

3.4.2.2.2 Emergency Flashers. Vehicle shall be provided with four-way emergency flashers with a visible and audible flash indicator. Emergency flashers shall be operable with engine starting switch "on" or "off".

3.4.2.3 Batteries. Each battery shall be of 12-volt potential. The total reserve capacity ratings and the total cold cranking ampere ratings at 0°F, both measured in accordance with SAE J537, shall be not less than specified in Table 1. The batteries shall be of the maintenance-free type having the maintenance-free characteristics.

Table 1. Batteries

Engine Type	Reserve Capacity (mins)	Cold Cranking (amps)
Diesel engine (less than 220 gross horsepower)	320	1,200
Diesel engine (220 gross horsepower and over	480	1,800

3.4.2.4 Radio Interference Suppression. The vehicle shall be suppressed to limit electromagnetic radiation in accordance with SAE J551. Suppressors used shall conform to SAE J552.

3.4.3 Fuel System. The fuel system shall conform to Federal Motor Carrier Safety Regulations 393.65 and 393.67.

3.4.3.1 Air Cleaner. The manufacturer's recommended standard air cleaner shall be furnished.

3.4.3.2 Fuel Tank(s). Fuel tank(s) shall be not less than 43 gallons total capacity. When more than one fuel tank is furnished on diesel engine driven vehicles, means shall be provided to assure equalized fuel level in both tanks.

3.4.3.3 Fuel and Water Separator. In addition to the manufacturer's standard fuel filter(s), a fuel and water separator shall be furnished. The separator shall include a water coalescer, a see-through bowl, and a drain valve.

3.4.4 Exhaust System. The exhaust system shall conform to Federal Motor Carrier Safety Regulation 393.83. A vertical exhaust system shall be provided. Vertical components capable of being reached easily by personnel entering or leaving either side of the cab shall be provided with a heat shield. Vertical exhaust systems shall be provided with a hinged rain cap. All horizontal portions of the system which project to the rear of the cab shall be provided with a cover plate that forms a shield to shed fluids and preclude spilled fuel from coming in contact with the exhaust system.

3.4.5 Transmission. The vehicle shall be equipped with an automatic or semi-automatic transmission. The transmission shall provide continuous drive. The transmission shall include a hydraulic torque converter and not less than four forward gear ratios. Normal driving range selector position shall provide not less than four gear ratios without movement of the selector. Net torque capacity of the transmission shall be not

less than 480 pound-feet with net input power rating of not less than 250 horsepower. The transmission shall provide the required vehicle performance in paragraph 3.3. The transmission shall be provided with a 6-bolt SAE J704 power takeoff opening for a converter-driven power takeoff. Transmission shall be Allison MT653DR or equivalent.

3.4.5.1 Power Takeoff. When a power takeoff (PTO) is furnished, it shall be of a rated capacity to operate powered equipment(see paragraph 3.6.8). Controls to operate the power takeoff shall be located in the truck cab accessible to the seated driver. A caution plate or decal reading "DO NOT OPERATE VEHICLE AT HIGHWAY SPEEDS WITH POWER TAKEOFF ENGAGED" shall be provided and installed so as to be readily visible to the seated driver. PTO shall have an air, electric, or mechanical shift mechanism with indicator light when PTO is engaged, and readily visible to the seated driver.

3.4.6 Drive Line Components. Drive line components shall be adequate to transmit the maximum delivered torque of the engine, as developed through the maximum gear train reduction.

3.4.7 Frame. The chassis frame shall consist of a heavy duty main frame and frame reinforcements. The heavy duty frame shall have frame rails of greater section modulus than the manufacturer's standard for the class of vehicle furnished. Frame rails shall not project beyond the rear end of the body. Frame reinforcements shall be in accordance with the crane manufacturer's recommendations for the size of hydraulic crane being mounted. Reinforcements shall extend at least from the rear of the front suspension, rear hanger bracket, to the front of the rear spring, front hanger bracket. Reinforcements shall provide sufficient structural strength in the chassis frame, through increased resisting bending moment, to at least equal the loads imposed with vehicle loaded to specified GVW.

3.4.8 Suspension. The vehicle shall be equipped with a suspension system, with components having a rated capacity at least equal to the load imposed on each member, measured at the ground, with the vehicle loaded to specified GVW. When suspension is rated at the spring pads, unsprung weight shall be deducted. The vehicle shall be equipped with hydraulic, double-acting shock absorbers at the front wheels and auxiliary rear springs.

3.4.9 Axles. Axle ratings shall be at least equal to the load imposed on each axle, measured at the ground, with the vehicle loaded to specified GVW.

3.4.10 Wheels, Rims, and Tires. The vehicle shall be equipped with single front and dual rear wheels. Rim and tire ratings shall conform to Tire and Rim Association recommendations for the type and size of tires furnished. Disc type wheels shall be furnished.

3.4.10.1 Tires. Tires shall be tube or tubeless type with highway tread. Tires shall be of rated capacity at least equal to the load imposed on each tire, measured at each wheel at the ground, with the vehicle loaded to specified GVW. Tires shall conform to Tire and Rim Association recommendations.

3.4.10.2 Inner Tubes. For tube type tires, inner tubes shall be of heavy duty type and shall be of proper size for tires furnished. Tire flaps shall be provided for tube type tires in accordance with Tire and Rim Association recommendations.

3.4.10.3 Balancing. Each tire shall balance within practicable limits. Wheels, hubs, and brake drums shall be effectively in balance. Balancing shall be adequate to preclude wheel shimmy at all effective speeds.

3.4.11 Brakes. Brakes shall conform to Federal Motor Carrier Safety Regulations 393.45 through 393.52.

3.4.11.1 Service Brakes. The vehicle shall be equipped with full-air brakes. The braking system, complete with all necessary components, shall include:

(a) Air compressor, unloader-head type, engine driven and engine lubricated, air or water cooled, and having a capacity of not less than 7-1/4 cubic feet per minute (cfm).

(b) Air storage reservoir(s) with not less than 2,000 cubic inches total capacity, each tank equipped with drain, and with safety and check valves between compressor and last reservoir tank.

(c) Foot control, suspended or treadle type.

(d) Air control valves.

(e) Air pressure gage, visible to the driver.

(f) Low air pressure warning, visible and audible.

(g) Service brake stop lamp switch.

(h) Alcohol aspirator with unbreakable transparent container.

(i) Automatic moisture ejector.

3.4.12 Cab. The chassis manufacturer shall furnish any type of his standard or optional full width cab. Cab doors shall be equipped with locks, operable from inside the cab through mechanical linkage, with at least the curb-side door equipped with external, key operated lock. Drip rails shall be installed above the cab doors. The cab shall have upholstered, full width, locking adjustable seat and back. White upholstery shall not be furnished. Interior lighting shall be provided. Manufacturer's standard fastenings and three pairs of seat belts shall

be installed on the vehicle. Safety grips shall be provided on each side of the cab to assist personnel in entering and leaving the cab. A sliding, lockable rear window shall be installed in cab to provide additional ventilation for cab space.

3.4.13 Steering. Power assisted steering shall be furnished.

3.4.14 Windshield Wipers and Washers. The vehicle shall be equipped with dual windshield wipers and windshield washers. Windshield wipers shall be multi-speed type and operated by either air or electric motor(s).

3.4.15 Bumper. Manufacturer's standard front bumper with access for towing devices shall be provided.

3.4.15.1 Rear End Protection. The rear of the vehicle shall be protected in accordance with Federal Motor Carrier Safety Regulation 393.86. A step type rear bumper shall be provided to provide personnel access to rear of body platform with access for towing devices.

3.4.16 Tool Stowage. Weather proof tool boxes mounted under body platform forward of rear axle on both sides of vehicle shall be provided. Tool boxes shall provide for locking with a padlock. Dimensions shall be not less than 18 inches in height by 20 inches deep by 48 inches in width.

3.4.17 Heater and Defroster. The vehicle shall be provided with a hot water heater with fresh air intakes and discharge outlets to floor and to windshield defroster louvers. Heater shall be complete with blower and mounted controls convenient to the driver.

3.4.18 Controls and Operating Mechanisms. All controls and operating mechanisms shall be located for left hand driver. Controls shall be complete and conveniently operable by the driver when in a seated position. Lever controls shall be designed and located to permit easy entrance and exit of the operator to and from driver's compartment. Instruments and controls shall be identified as to their function and installed in a manner to facilitate removal and servicing. All instruments shall be visible to driver when seated in driving position.

3.4.19 Accessories and Equipment. Chassis equipment shall be complete with all accessories furnished as standard equipment by the manufacturer. The following minimum equipment shall be furnished:

(a) Key operated ignition switch.

(b) Ammeter or voltmeter.

(c) Fuel gage.

(d) Oil pressure gage.

(e) Engine temperature gage.

(f) Speedometer with recording odometer.

(g) Dual sunvisors.

(h) Driver's compartment ventilator other than window.

(i) Tachometer.

(j) Headlight high beam indicator light.

(k) Driver's compartment dome light.

3.4.20 Rearview Mirrors. Outside rearview mirrors shall be mounted on each side of the cab. The mirrors shall be of the combination type having flat and convex areas enclosed in a common housing. The flat portion shall have not less than 50 square inches of reflective area. The convex portion shall have not less than 20 square inches of reflective area. The mirrors on conventional cabs shall have not less than three supporting arms.

3.4.21 Horn. Manufacturer's standard electric horn shall be furnished.

3.4.22 Engine Hour Meter. An engine hour meter having a totalizing mechanism of not less than 9,999 hours shall be furnished for the chassis engine to register accurately the number of hours of operating time. The meter shall be of rugged construction to insure continuous free performance under severe operating conditions. The engine hour meter shall be mounted on or near the cab instrument panel in a readable location. Engine meter shall be mounted adjacent to the hydraulic system hour meter (see paragraph 3.6.8.4) and labeled accordingly (engine).

3.4.23 Back-up Alarm. The vehicle shall be provided with an audible, pulsating, signaling device (electrical or mechanical) to caution personnel when the vehicle is in reverse gear operation. Output shall be not less than 100 db at 10 feet.

3.5 Vehicle Body.

3.5.1 Cab-axle Dimension. Cab-axle dimension for vehicle with mounted crane shall be minimum 138 inches. Greater CA dimension may be required in accordance with crane manufacturer's recommendations.

3.5.2 Body. Body shall be provided with steel subframe, wood platform, and steel platform rails with internal stake pockets. No stake body racks shall be provided. The body shall be mounted to provide a space with a back of cab-to-body distance as required for mounting hydraulic crane.

3.5.3 Body Frame. Body framing shall be a completely welded structure with members of minimum gage thickness specified in Table 2 for carbon steel; high tensile steel may be furnished in two gages lighter weight in accordance with US Standard gage sizes. There shall be not less than 12 full width crossmembers, including ends and stub crossmembers as required for proper spacing over axle. Crossmenbers shall be of the full channel construction, reinforced by gusset plates or brackets at points of attachment to longitudinal sills, and contact edges of welded reinforcements shall be welded for not less than 50 percent of the edge length. Longitudinal sills shall be constructed of structural steel channel or formed channels. Formed channel sills shall be reinforced within the sill, at each crossmember or body mounting point, with formed channel reinforcements.

Table 2. Framing Gages

Framing member	US Standard gage number	Equivalent inches
Crossmembers	10	0.1345
Side and end rails	10	0.1345
Longitudinal sills	8	0.1644
Reinforcements	8	0.1644
Rack posts	11	0.1196
Rack post with reinforced lower section	12	0.1046

3.5.4 Body Rails. Forward, rear, and side rails of platform shall have internal stake pockets. Upper edge of rails shall have smooth radius to reduce chafing or abrasive damage to rubber jacketed cables loaded and transported on platform.

3.5.5 Wood Floors. Platform shall be wood floored longitudinally with either ship-lap or tongue-and-groove joints. Wood flooring shall be of hardwood or dense southern yellow pine not less than 1-5/16 inches thick (finished dimension). Wood shall be treated in accordance with MIL-STD-1223 or treated with two coats of manufacturer's standard high quality wood preservative.

3.5.6 Body Mounting. Body shall be secured with U-bolts, twin studs, brackets, or J-bolts and shall include a wood breaker strip.

3.5.6.1 U-bolts or Twin Studs. When U-bolts or twin studs are used, there shall be not less than four U-bolts or twin studs per side, each having 9/16-inch body diameter with 5/8-inch minimum thread diameter. Tie-plates shall be at least 1/2 inch thick. The vehicle chassis frame shall be braced, using wood blocks at each mounting point unless mounting point is located at a full depth, frame crossmember. Blocks shall incorporate a keeper strap or groove for mounting bolt, and shall be of a width and thickness to assure retention. Two tie-back straps

shall be provided, one bolted to each side of the rear portion of the body subframe, to maintain body alignment on vehicle chassis. Forward body mounting bolts shall be located to the rear of the tapered portion of breaker strips (see paragraph 3.5.6.4).

3.5.6.2 Brackets. When brackets are used, they shall be bolted to the web of the chassis frame rails. The body mounting brackets shall provide means for drawing down the body on the chassis rails, and provisions shall be made to prevent lateral shifting of the breaker strips. When additional holes are required to secure mounting brackets to chassis frame rails, they must be located within the area of the rail which is designated as being safe for drilling in accordance with the chassis manufacturer's body builders layouts. Attachments shall not interfere with nor obstruct chassis components.

3.5.6.3 J-bolts. When J-bolts are used, there shall be not less than nine J-bolts per side, each not less than 3/8 inch in diameter. J-bolts shall encircle the lower chassis frame flange. Two tie-back straps as specified in paragraph 3.5.6.1 shall be provided. The forward J-bolts shall be located to the rear of the tapered portion of the breaker strips (see paragraph 3.5.6.4). Provisions shall be made to prevent lateral shifting of the breaker strips.

3.5.6.4 Breaker Strips. A hardwood or dense southern yellow pine breaker strip of not less than 1-1/16 inches finished thickness shall be installed between longitudinal sills and vehicle chassis frame. Breaker strips shall have a taper of 1 inch in 18 inches at the forward end.

3.6 Hydraulic Crane. The vehicle shall be furnished with a one man-operated, fully hydraulic, telescoping boom-type crane, mounted on the truck frame between the cab and the platform. Crane shall meet all design, construction, and safety standards in effect at date of manufacture. Except as specified herein, the crane, components, assemblies, and accessories to be delivered under the contract, shall be standard or optional items which meet or exceed the requirements of this purchase description. Crane items shall be as represented in the crane manufacturer's technical data.

3.6.1 Crane Capacity. Minimum reach (radius not greater than 5 feet) crane capacity shall be 20,000 pounds minimum. Maximum reach (horizontal extended boom - radius not less than 54 feet) crane capacity shall be 1,000 pounds minimum. Crane capacity above shall be available for 360 degree work area. Crane capacity specified does not include rigging hardware and attachments. Outriggers shall be extended in all cases.

3.6.1.1 Capacity, Height, and Radius Information. A metal placard shall be furnished at both operator stations to readily display capacities at various boom heights and radii to equipment operator.

3.6.2 Telescoping Boom. A 3 (three) section, fully hydraulic, telescoping boom with sequencing 2nd and 3rd stage hydraulic extension cylinders shall be provided. Boom assembly shall have minimum retracted length of 22 feet and minimum fully extended length of 54 feet. Boom

length shall be measured from centerline of boom pivot pin to centerline of head sheave pin. Pilot-operated check valves shall be provided to hold telescoping cylinders in place while under load or in the event of hydraulic failure. No slide tubes or hose reel assemblies for boom extension are acceptable. Boom sections shall have easily replaceable boom wear pads and lubrication fittings as required. All revolving components, particularly boom head sheave, shall lubrication fittings.

3.6.3 Boom Rotation. Boom rotation shall be minimum 360 degree non-continuous with bidirectional motor driving a gear reduction unit. Pinion and turntable gear shall be protected from direct exposure to atmosphere due to severe salt water environment. Turret/turntable assembly shall have hydraulic motion control valve to reduce side or shock loads due to sudden stops when swinging.

3.6.4 Boom Elevation. Boom elevation angles shall range from -10 to 80 degrees from horizontal. Boom topping cylinder shall have integral holding valve to prevent boom or load from dropping in the event of hydraulic system failure. Base end of topping cylinder shall have self-aligning bearing. Elevation angle indicator(s) shall be provided and shall be readily visible to the operator at all times. Provision for lowering boom in the event of hydraulic system failure shall be provided.

3.6.5 Boom Height. Minimum boom height when fully extended at 80 degrees shall be 64 feet from ground to centerline of sheave pin when crane is mounted on 40-inch frame.

3.6.6 Outriggers. Main outriggers (attached to crane pedestal) and auxiliary outriggers (mounted behind rear axle) shall be provided. The outriggers shall enable leveling of the vehicle on inclined surfaces and insure adequate stability for the mounted crane. Front stabilizers shall be installed if required for stability of boom and truck in 360 degree work area.

3.6.6.1 Main Outriggers. A frame, box type, swing out and down outriggers mounted on crane pedestal with integral holding valves to prevent outrigger drift or retraction during boom operations or in the event of hydraulic failure shall be provided. Minimum outrigger spread measured from centerline of each outrigger shoe pin shall be 15 feet (measured at ground level). Outrigger penetration below ground level shall be minimum six inches. Each outrigger shall have its own control valve. The outrigger cylinder fittings, hoses, and pilot-operated check valves, when not enclosed, shall be protected by metal guards and provide accessibility for servicing.

3.6.6.2 Auxiliary Outriggers. A frame, box type auxiliary outriggers with holding valves to prevent outrigger drift or retraction during boom operations or in the event of hydraulic failure shall be provided. Minimum outrigger spread from outside of each shoe (measured at ground level) shall be 10 feet. Outrigger penetration below ground level shall be minimum 6 inches. Each outrigger shall have its own control valve.

3.6.6.3 Front Stabilizers. Front stabilizers mounted to bumper or supporting frame shall be provided, if required, to maintain stability of boom and truck in 360 degree work area. Holding valves shall be provided to prevent stabilizer retraction or draft during boom operation or in the event of hydraulic failure. Stabilizer shoe penetration below ground level shall be 6 inches. One control valve for both stabilizers is acceptable with handles (mechanical linkage) at both operator stations.

3.6.7 Winch. A boom base mounted, single speed, planetary gear winch with minimum 8,000 pounds, bare drum, single line pull shall be provided. Winch shall incorporate a hydraulic operated brake so the loads will not "free fall" or drop when winch control handle is released or in the event of hydraulic failure. Bare drum line speed shall range from 0-100 feet/minute.

3.6.7.1 Loadline. A minimum 220 feet of 1/2 inch 6X19 IWRP X IPPRL wire rope or wire rope of not less than greater breaking strength shall be provided. Loadline shall be no larger in diameter than 9/16 inches. Loadline shall be furnished with minimum 40 pound downhaul weight with open swage socket installed on wire rope furnished. Load line guides shall be provided on boom assembly.

3.6.8 Hydraulic System. A hydraulic tandem pump driven from a power takeoff attached to the truck chassis transmission and controlled from inside the truck cab shall be provided to furnish power for the crane. The tandem pump shall be of the positive displacement type and shall provide a working pressure of not less than 2,500 psi and minimum 40 gallon per minute (gpm) flow rate divided between pumps (i.e., 25 gpm/15 gpm split).

3.6.8.1 Oil Reservoir. A hydraulic fluid reservoir shall be provided with sufficient size and capacity to hold the required fluid volume (including minimum 10% expansion space) and ensure adequate cooling of fluid. Excessive heating (approximately 180°F of the fluid shall not be acceptable under any operating conditions. Filtration shall consist of a 10 micron return oil filter with automatic bypass and filter condition indicator, and 100 mesh magnetic suction separator. Reservoir shall be provided with a built-in check valve if required, to replace filter without draining reservoir. A fill tube and breather cap with dipstick or other fluid level indicator (sight tube), shall be provided. Intake and return lines to reservoir shall be located below minimum working fluid level to prevent cavitation or aeration. Baffles or other means to separate air or foreign material from intake and return lines in reservoir shall be provided. Provision shall be made for inspection and cleaning of the interior and draining of the reservoir. Reservoir drain shall be located to prevent draining of fluid on other vehicle components and allow fluid recovery into a container. The reservoir shall have a corrosion resistant, etched plate indicating type of fluid required and maximum fluid level with hydraulic system full and boom in travel position.

3.6.8.2 Hydraulic Controls. Control valves shall be open center four way, three position, with fine metering spools to provide infinitely variable control over all crane functions. Control valves shall have built in relief valves for hydraulic system protection.

3.6.8.2.1 Control Stations. Crane shall be provided with dual side operator control stations with hydraulic operated engine accelerator at each station. A truck engine start/stop switch shall be provided and located to be easily accessible from both operator stations. A stainless steel bubble type level shall be provided at each control station within clear visibility of operator and with accuracy within one degree of horizontal. Safety guards at operator station shall be provided to prevent bodily injury from extending or retracting main outriggers. Outrigger control valves shall be arranged to prevent accidental actuation by operator while operating other crane functions. Operator platform shall be provided with step, grab handle, and platform surface of safety tread steel grating or equivalent. Grab handle above shall be installed as to assist personnel in stepping up onto body platform, without using control valve handles or other supporting devices. Identification plates shall be provided at controls to identify their function.

3.6.8.2.2 Boom/Winch/Tool Circuit Controls. Boom topping, boom swing, boom telescope and tool circuit (see paragraph 3.6.8.3) directional control valves shall be sectional, hydraulic, remote spool actuated, spring centering, with fine metering spools (Gresen V20 with HRO option or equivalent). Winch directional control valves shall be direct lever or remote spool actuated (at manufacturers option), spring centering, with fine metering spools (Gresen V42 (optional with HRO option) or equivalent). Boom, tool circuit and winch valve assemblies shall have built-in relief valves in inlet cover. Tool circuit function control valve shall be placed in downstream position if installed in boom control valve assembly to allow for reduced working pressure using sectional relief valve or work port relief valves (see paragraph 3.6.8.3 for working pressure).

For remote spool actuated valves, remote hydraulic controllers shall be installed at both operator stations. Dual joystick type controllers (Gresen HCJ or equivalent) shall be installed for simultaneous operation of boom topping and boom swing functions. Sectional, hydraulic, single type controllers (Gresen HCS or equivalent) shall be installed for boom telescope and tool circuit functions. A pressure reducing, priority type flow control valve shall be installed in high pressure hydraulic system to provide pilot supply requirements in accordance with controller manufacturers' recommendations (usually 300 psi, 4 gpm).

Control handles at both operator stations shall be provided for winch control via mechanical linkages or sectional remote hydraulic controllers (Gresen HCS or equivalent) at manufacturers' option.

Control handles at operator station shall be not less than 4 inches apart. More space shall be provided, if required, for joystick to avoid interference with adjacent controls. See Figure A-1 for recommended layout.

3.6.8.2.3 Outrigger Controls. Outrigger control valve shall be spring centered, with fine metering spools and mechanical linkage to provide control handles at both operator stations. A means to disengage controls or installed guard to prevent accidental actuation of outrigger controls during crane operations shall be provided.

3.6.8.3 Hydraulic Tool Circuit. In addition to the manufacturer's standard boom and winch functions, the crane shall be provided with a hydraulic tool circuit providing a maximum pressure of 1,500 psi and maximum flowrate of 15 gal/min.(gpm) to a bidirectional hydraulic motor(ROSS Torqmotor Model no. MAB-08). The control valve shall be in accordance with paragraph 3.6.8.2.2. Tool circuit function shall be provided with valves, fittings, hoses, and tubing required to deliver fluid to a spring-retract hose reel(s) mounted on the outer boom section. The spring-retract hose reel shall have capacity to handle two (2)-1/2 inch hydraulic hose with adequate spring tension to fully retract hoses under all operating conditions. Hydraulic hoses (two each) shall be minimum fifty (50) feet in length, conforming to SAE 100R2 Type AT, with fittings to match hose reel outlets and terminated with 1/2 inch male NPT fittings and 1/2 inch female NPT self-sealed, quick-disconnect couplers (Parker Series 60 - steel or equivalent). Hose-reel assembly shall be mounted not more than four (4) feet from boom tip end of outer boom section. A fairlead assembly, consisting of two (2) minimum 11-inch-diam pulleys with grooves to match outside diameter of hoses shall be mounted at boom tip end of outer boom section. Fairlead assembly shall include support structure for pulleys and be designed to not interfere with boom extension/retraction and permit smooth rewind and payout of hose on reel. All hoses, fittings, and adapters provided for hydraulic tool circuit shall be installed to prevent chafing or crimping of hoses under all boom operating conditions. Cable grips (Kellems - closed single eye standard type or equivalent) to match hose outside diameter shall be installed on both hose reel hoses (see Figure A-2).

3.6.8.3.1 Hydraulic Tool Circuit Attachments. Cable handling tool circuit attachments shall consist of a load carrying swivel assembly (Mobile Equipment Co., Bakersfield, Calif., Model LCS-8 or equivalent), a power block (Marco Seattle, Seattle, Wash., Model B19B/919B with power grip or equivalent (see Figure A-3)), and required hydraulic fittings and hoses. Swivel assembly, lower bracket, and power block shall be assembled using a 3/4-10 x 4 inch Grade 8 bolt with nylon compression nut and two (2) 3/8-16x 1-inch machine screws (see Figure A-4). Swivel/ power block assembly shall be attached to open socket on loadline. Half-inch SAE 100R2 Type AT hoses and required fittings shall be installed between outlet ports (1/2-NPT) of swivel and power block motor inlet ports (1/2-NPT). Barko type swivel joints (90 degree-3,000 psi rating) shall be installed in swivel assembly inlet parts (1/2-NPT) with self-sealing quick-disconnect couplers to match couplers in paragraph 3.6.8.3. A 1-ton anch or shackle with screw pin (Crosby G-209 or equivalent) shall be welded to upper bracket of swivel assembly (see Figure A-2) for attaching grips installed on hose reel hoses (see paragraph 3.6.8.3). Power block ring gear shall be lubricated generously with heavy duty open

gear lubricant. Load carrying swivel assembly shall allow free rotation without binding hydraulic hoses by adjusting lock nut and cotter pin as required.

3.6.8.3.2 Power Block-Securing Straps. Chain or wire rope straps shall be installed on tow hooks or eyelets (as required) on rear bumper for securing power block during transport. Ends of each chain/wire rope shall be provided with 7/16-inch snap hooks (Crosby G-3315 or equivalent) (see Figure A-5).

3.6.8.4 Anti-Two Block System. An anti-two block system shall be provided to prevent two blocking loadline down haul weight against the bottom of the sheave head, particularly when extending telescoping boom. System shall, as a minimum, consist of chain supported block on loadline to activate switch at boom tip. Switch shall actuate valves to divert fluid from winch 'up' and boom 'telescope' functions. Valves and required components furnished shall be at manufacturer's option. Visual indicator(s) of anti-two block system in operation shall be provided at both operator stations within clear visibility of operator. Operator procedure(s) shall be posted at both operator stations in a readily visible location for operator.

3.6.8.5 Hydraulic System Hour Meter. An hour meter having a totalizing mechanism of not less than 9,999 hours shall be furnished for the crane hydraulic system to register accurately the number of hours of operating time. The meter shall be of rugged construction to insure continuous trouble free performance under severe operating conditions. The hydraulic system hour meter shall be mounted on or near the cab instrument panel in a readable location. Hydraulic system meter shall be mounted adjacent to the engine hour meter (see paragraph 3.4.22) and labeled accordingly (HYD sys). Hour meter shall be activated only when power takeoff (PTO) for hydraulic system is engaged using a pressure switch tapped into hydraulic pressure lines or electrical switch linked to PTO control.

3.6.8.6 Crane Boom Rest. A portable boom rest mounted in vehicle body stake pockets to support boom during transit shall be furnished. Boom rest shall be light enough to be removed from vehicle platform by one man. Height of boom shall be designed to provide a minimum clearance of 2 feet between ground and base of power block when power block swivel assembly (approximately 56 inches in length) is secured to vehicle and loadline is hoisted to trip anti-two block switch (see Figure A-5).

3.6.9 Crane Safety Features. The crane and hydraulic system shall contain the following minimum safety features:

(a) Holding valves in boom and outrigger cylinders to prevent load drop or instability due to hydraulic system failure.

(b) Cushioning valve in boom rotating system to preclude damage due to sudden stops.

(c) Pressure relief valves to protect hydraulic system.

(d) Anti-two block control system to prevent damage to loadline or sheave head from two blocking, particularly during boom telescoping operation.

(e) Caution signs, crane capacity chart, crane hand signal chart, and any required safety information shall be posted in positions clearly visible to operator at both operator stations.

(f) Caution signs or other warning notices shall be placed conspicuously on vehicle to alert non-operating personnel to equipment hazards.

3.6.10 Boom Lighting. Lights for night operations of the vehicle shall be provided. Two (2) sealed beam spotlights with 2-axis control shall be mounted on or behind cab within easy reach of operator at operator station. Spotlights shall be located to provide minimum obstruction of light beam from swinging boom (i.e., mounted behind corners of cab). In addition, two (2) sealed beam floodlights shall be mounted on either side of outer boom section to illuminate sheave head at all times. Switches for lights shall be mounted in cab in a location conveniently operable by driver and labeled accordingly - "(driverside)SPOT/FLOODS/SPOT(pass. side)"

3.7 Lubrication System. The lubrication shall be furnished for the vehicle and mounted crane with fittings for all bearings and other working parts which require lubrication for continued srevice. Required lubricants, lubrication schedule, and lubrication chart shall be provided in other operators manuals or other documents.

3.8 Servicing and Adjusting. Prior to acceptance of the vehicle by the Government inspector, the contractor shall service and adjust each vehicle for operational use including at least the following: charging of batteries; alignment of front wheels; inflation of all tires; complete lubrication of chassis, engine, and running gear with grades of lubricants recommended for the ambient air temperature at the delivery point; servicing of cooling system with a solution of ethylene glycol type antifreeze and water in equal parts by volume and servicing of windshield washer reservoir with water and appropriate additives. The hydraulic crane shall be adjusted and serviced as prescribed by crane manufacturer including filling of reservoir and lubrication with lubricants recommended for ambient air temperature at the delivery point.

3.9 Workmanship.

3.9.1 Metal Fabrication. Metal used in fabrication of equipment shall be free from kinks, and sharp bends. The straightening of material shall be done by methods that will not cause injury to the metal.

Shearing and chipping shall be done neatly and accurately. All bends of a major character shall be made with controlled means in order to insure uniformity of size and shape.

3.9.2 Bolted Connections. Bolt holes shall be accurately punched or drilled and shall have the burrs removed. Washers or lockwashers shall be provided in accordance with good commercial practice, and all bolts, nuts, and screws shall be tight.

3.9.3 Riveted Connections. Rivet holes shall be accurately punched or drilled and shall have the burrs removed. Rivets shall be driven with pressure tools and shall completely fill the holes. Rivet heads, when not countersunk or flattened, shall be of approved shape and of uniform size for the same diameter of rivet. Rivet heads shall be full, neatly made, concentric with the rivet holes, and in full contact with the surface of the member.

3.9.4 Welding. Welding procedures shall be in accordance with a nationally recognized welding code. The surface of parts to be welded shall be free from rust, scale, paint, grease, or other foreign matter. Welds shall be of sufficient size and shape to develop the full strength of the parts connected by the welds. Welds shall transmit stress without permanent deformation or failure when the parts connected by the weld are subjected to proof and service loadings.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the purchase description where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Examination. Each truck shall be examined for compliance with the requirements specified in Section 3 of the purchase description. Any redesign or modification of the contractor's standard product to comply with specified requirements, or any necessary redesign or modification following failure to meet specified requirements shall receive particular attention of adequacy and suitability. This element of inspection shall encompass all visual examinations and dimensional measurements. Noncompliance with any specified requirements or presence of one or more defects preventing or lessening maximum efficiency shall constitute cause for rejection.

4.3 First Production Vehicle Inspection. The first production vehicle produced under the contract shall be inspected by the contractor at his plant under the direction and in the presence of Government representatives.

The purpose of the inspection shall be to determine vehicle conformity with the requirements of the contract. Acceptance of the first production vehicle shall not constitute a waiver by the Government of its rights under the provisions of the contract.

4.3.1 Vehicle Weight. The vehicle shall be weighed to determine curb weight and distribution of curb weight on front and rear axle. The imposed loading on front and rear axle will be computed using the curb weight and the payload (see paragraph 3.2.5) to provide the specified GVW. The calculated imposed loads on front and rear axle will be utilized to ascertain that the suspension, axles, and tires furnished are of adequate capacity to meet the requirements of paragraphs 3.2.4, 3.2.5, and 3.2.6.

4.3.2 Road Test. The vehicle shall be examined and road tested (less payload) by the contractor to assure that the vehicle will operate in accordance with contractual requirements (paragraph 3.3).

4.3.3 Height, Reach,and Rotational Speed Test. The crane shall be tested by operating each crane function through at least one cycle (i.e extend/retract boom) at engine speed of at least 1,800 rpm with no load on a clear level surface. Boom tilt function shall be performed with boom fully extended. Measured height of sheave pin centerline above level ground with boom fully extended and boom angle of 80 degrees from horizontal shall conform to paragraph 3.6.5. Boom reach shall be measured from boom pivot pin to sheave head pin with boom fully extended and horizontal for conformance to paragraph 3.6.2. Boom rotation speed shall be not less than 1-1/2 rev./min. Crane shall be inspected for hydraulic leaks, evidence of abnormal wear and smooth motion during operation.

4.3.4 Load Test. The boom shall be operated with a measured load of not less than 2,000 pounds using a single part line. With outriggers extended and vehicle leveled, the boom shall be operated within safe operating limits for the test load. Boom shall be rotated through full work area, retracted, extended, elevated, lowered, and winch raised and lowered. Boom winch operations shall be conducted in a random manner and in random combinations at full speed, for all capable positions of the boom. Hydraulic system shall be stopped and restarted from the operator station randomly during the course of the test. Stalling of the vehicle; inability to rotate, elevate, lower, extend, or retract at required speeds; lifting of any outrigger off the ground (if within stability limits); part failure or permanent set shall constitute failure of the test.

4.3.5 Position Holding Ability. The vehicle shall be set up with outriggers extended and vehicle leveled. Using a 2,000 pound load position the boom at right angles to the longitudinal axis of the vehicle. With the boom fully extended at a radius of 40 feet lift the load using the winch line approximately six (6) inches of the ground. Measure the position of the sheave head centerline relative to a fixed point. Turn the vehicle engine off. Measure the sheave head centerline

relative to the same fixed point after an elapsed time of not less than one (1) hour. Horizontal creep of more than one (1) inch and vertical settling of more than one (1) inch in one hour shall constitute failure.

4.3.6 Stability Test. Using the 2,000 pound load above operate the boom at right angles to the longitudinal axis of the vehicle. With the boom fully extended lower boom with load suspended in air to locate the radius and boom angle where the outrigger on the opposite of the vehicle is no longer firmly set on the ground. Note the position of the boom and check load chart for compliance with stability rating. A radius less than or boom angle greater than specified for stability shall constitute failure. Repeat procedure for boom over front of vehicle and use rear outriggers for stability check.

4.3.7 Crane Weight Test Certification. Contractor shall provide certification of crane weight test in accordance with SAE standards.

4.3.5 Wood Treatment Certification. Contractor shall provide certification of wood treatment as specified in paragraph 3.1.1.6.

5.0 PREPARATION FOR DELIVERY

5.1 Vehicle Processing. Vehicle shall be processed for shipment, from manufacturer's to plant initial receiving activity, in accordance with manufacturer's standard commercial practice.

6.0 NOTES

6.1 Intended Use. The vehicles covered by this purchase description are intended for non-tactical use by the Government for: mounting special equipment to handle 3-conductor electrical (non-energized) cables in support of Public Works utilities operations; and transporting personnel and cargo (i.e., cable).

6.2 Commercial Publications. Publications shall contain the following manufacturer's or commercial publications applicable to each equipment delivered under the contract (including special equipment.)

(a) Operators manual with lubrication chart.

(b) Parts Manuals. (These manual(s) must contain parts lists and part numbers for all parts, assemblies, and subassemblies including but not limited to, engines, electric motors, pumps, etc).

(c) Shop maintenance, service and repair manual(s). (These manuals must contain information regarding diagnosis, servicing techniques, disassembly, repair, assembly procedures, etc., for all equipment, assemblies, subassemblies supplied under the contract).

(d) Handbook for special equipment furnished (i.e., anti-two block system).

6.3 Recommended Spare Parts List. The contractor's deliverable data shall include a spare parts list. The list may be arranged in any comprehensive presentation of components, assemblies, and subassemblies, however, each item shall include the following:

(a) Equipment manufacturer's Part Number.

(b) Equipment manufacturer's nomenclature.

(c) Unit of issue and price.

(d) Quantity used in the assembly of each unit.

(e) Recommended quantity for support of (1) one unit for the first 500 hours of operation.

(f) Recommended quantity for support of (4) four units for the first 500 hours of operation.

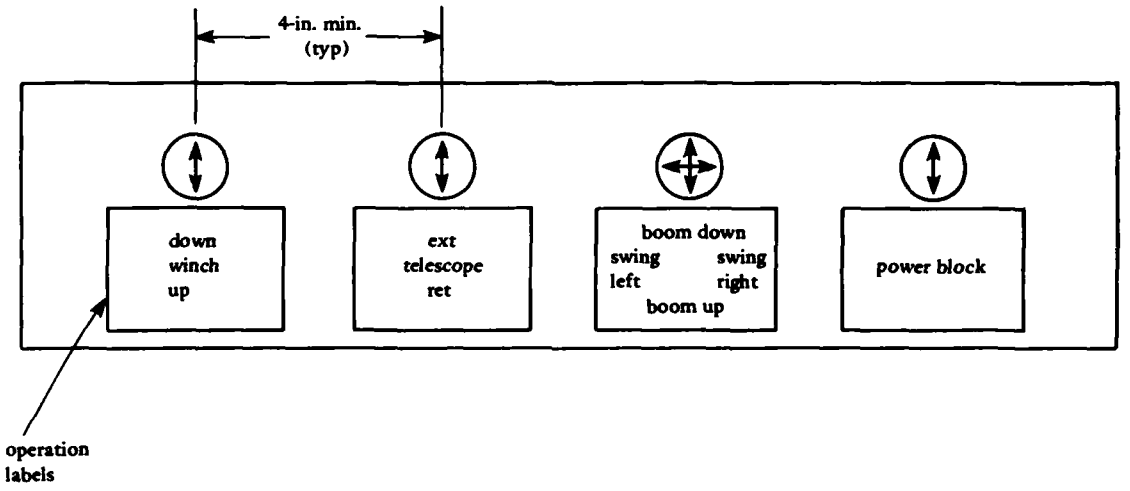

Figure A-1. Recommended control station layout for boom operating functions.

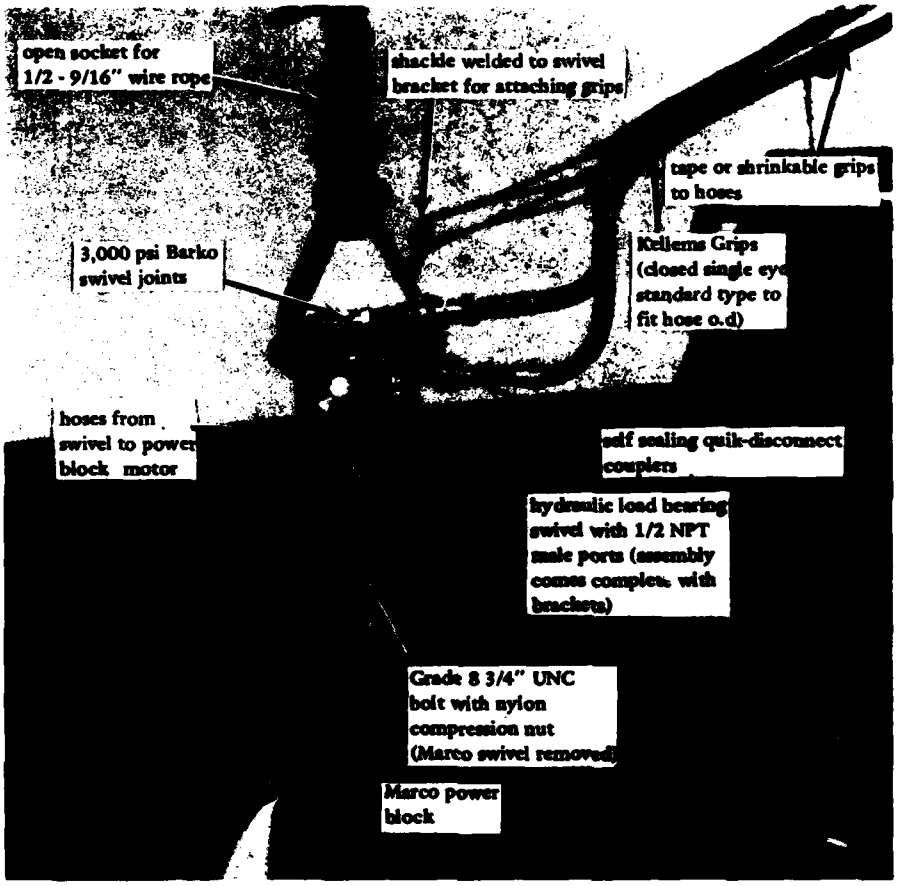

Figure A-2. Cable grips installed on both hose reel hoses.

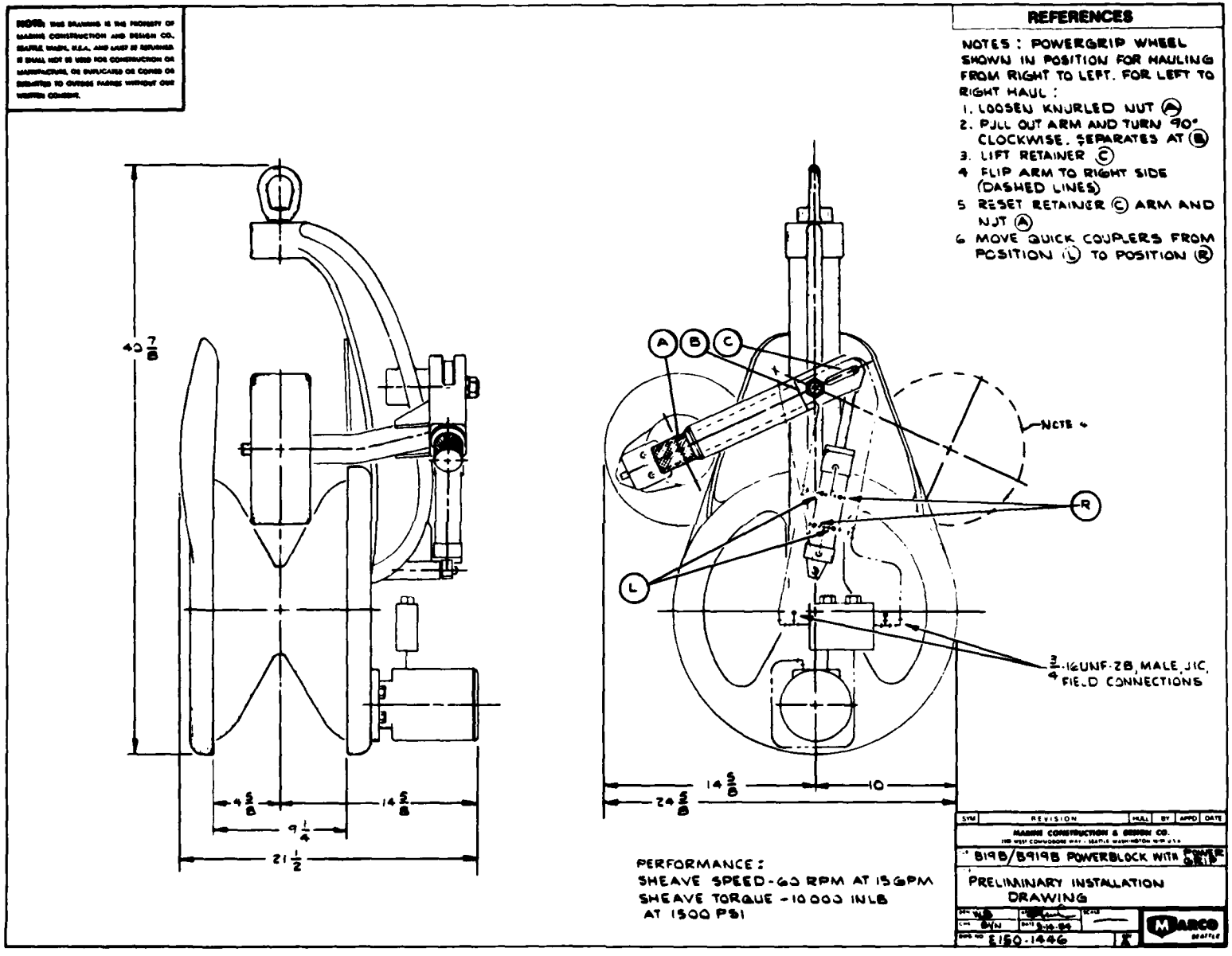

Figure A-3. Assembly of load carry swivel and power block.

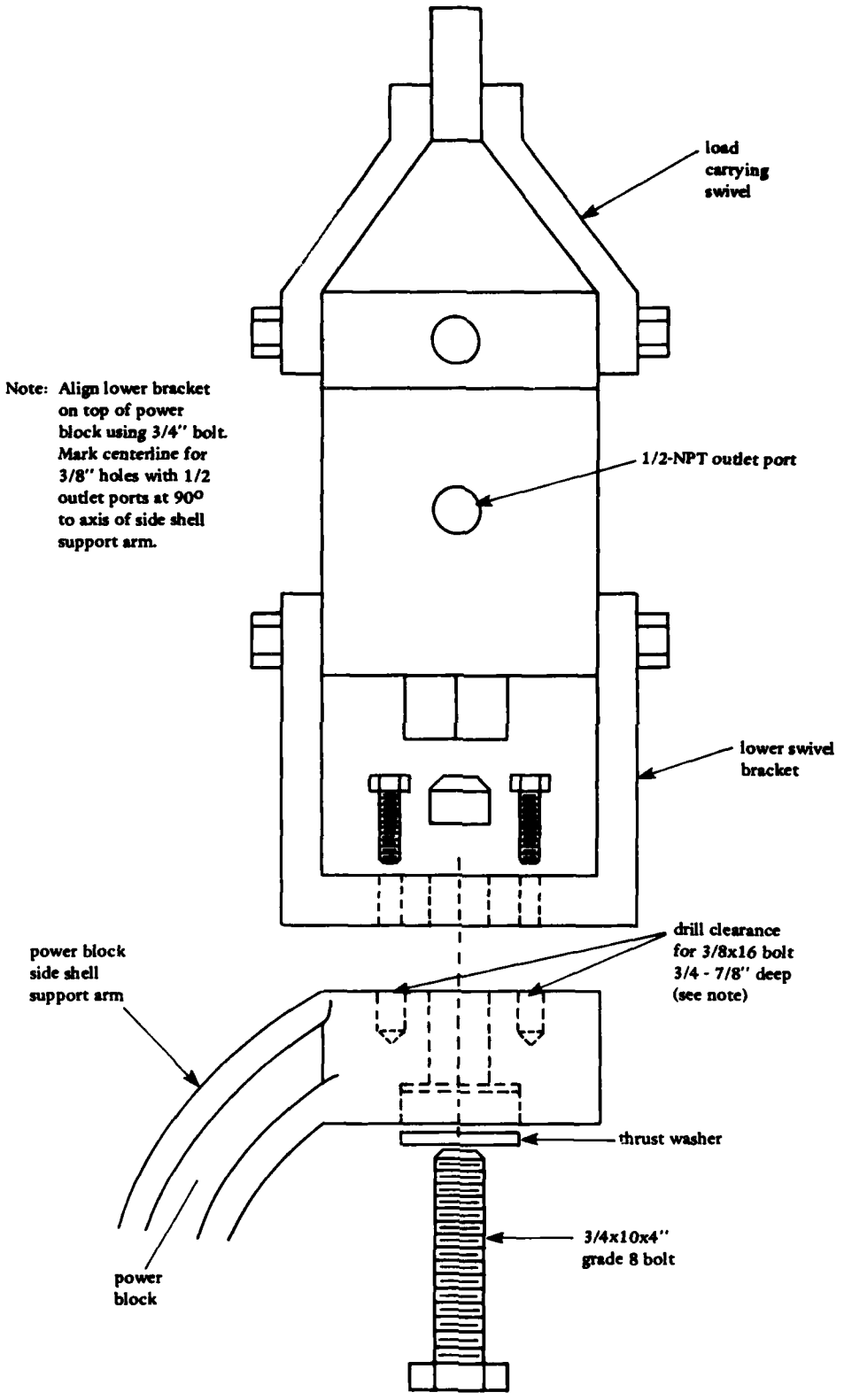

Figure A-4. Assembly of load carry swivel and power block.

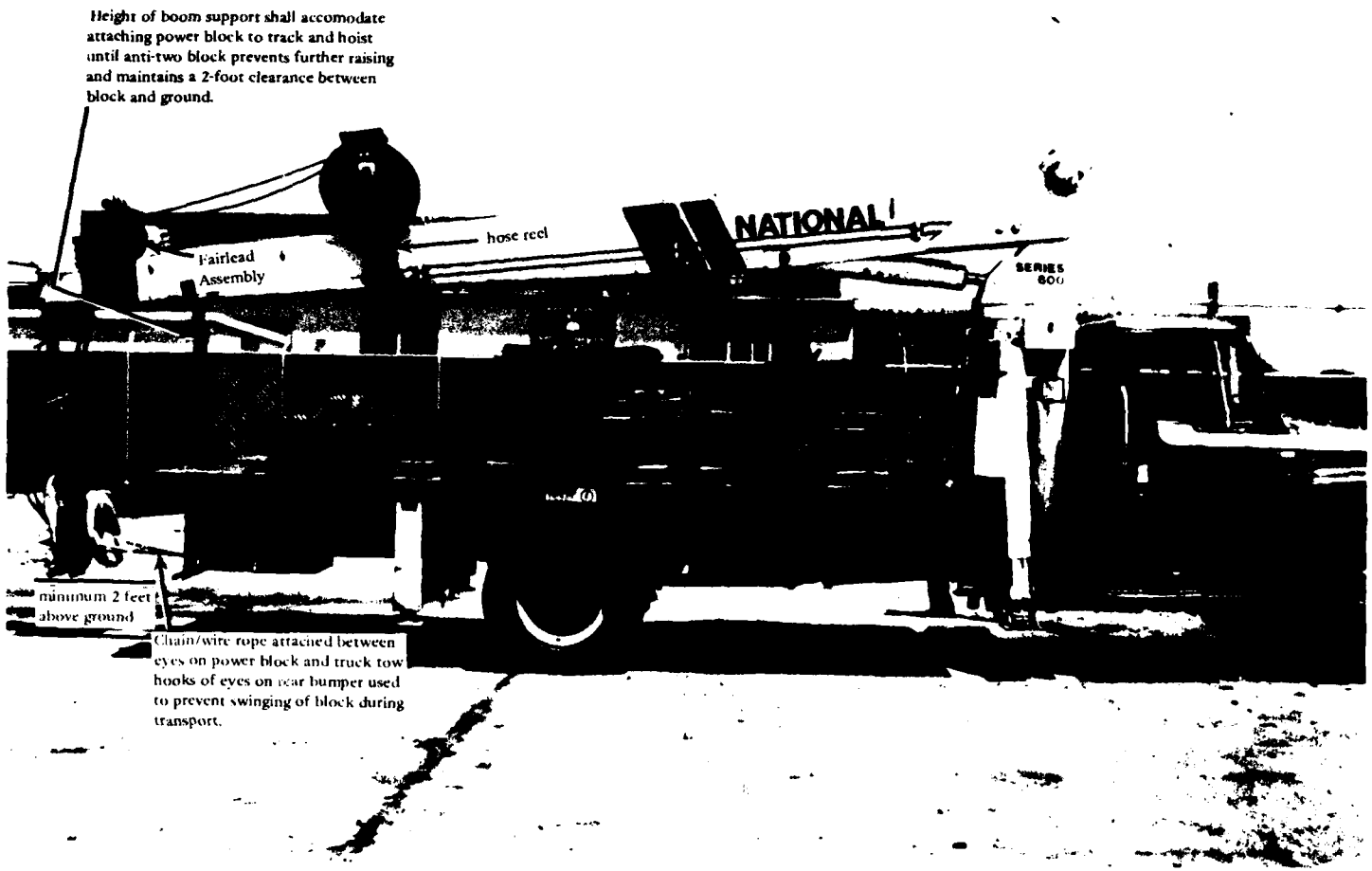

Figure A-5. Power block securing straps.

Appendix B

PARTS AND MATERIALS LISTS

LOW PRESSURE SYSTEM PARTS

SCHEMATIC PART #	DESCRIPTION	SAE #	QTY
1	FITTING - 3/8 M-ORING/ 3/8 M-JIC (90)	070220	2
2	HOSE ASSEMBLIES-3/8" MIDIUM PRESSURE (2 HOSES) W/END FITTINGS 3/8 F-JIC (BOTH ENDS)	100R5 (W/RUBBER COVER)	6' 4
3	FITTING - 3/8 M-ORING/ 3/8 M-JIC	070120	4
4	HYDRAULIC REMOTE CONTROLLER	SEE ORDER LIST	1
5	HOSE ASSEMBLY - 3/8" MEDIUM PRESSURE W/END FITTINGS - 3/8 F-JIC 3/8 F-JIC (90 SHORT)	100R5 (W/RUBBER COVER) ---------- ----------	4' 1 1
6	HOSE ASSEMBLY - 3/8" MEDIUM PRESSURE W/END FITTINGS - 3/8 F-JIC 3/8 F-JIC (90 SHORT)	100R5 (W/RUBBER COVER) ---------- ----------	2' 1 1
7	FITTING - 1/2 M-NPT/ 3/8 M-JIC	070102	1
8	FITTINGS - 3/8 M-NPT/ 3/8 M-JIC	070102	1
9	HOSE ASSEMBLY - 3/8" MEDIUM PRESSURE W/END FITTINGS - 3/8 F-JIC 3/8 F-JIC (90 SHORT)	100R5 (W/RUBBER COVER) ---------- ----------	3' 1 1
10	FITTING - SWIVEL NUT BRANCH TEE 3/8 M-JIC ENDS/ 3/8 M-JIC BRANCH	070433	1
11	FITTING - REDUCER 3/4 F-JIC/ 3/8 M-JIC	070123	1

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HIGH PRESSURE SYSTEM PARTS

SCHEMATIC PART #	DESRIPTION	SAE #	QTY
1	FITTING-3/4" ORING PLUG	090109	1
2	FITTING-5/8" M-ORING/ 3/4 M-JIC 90	070220	1
3	3/4" HIGH PRESSURE HOSE	1000R2-TYPE AT	3'
	W/END FITTINGS 3/4" F-JIC	-------	1
	3/4" F-JIC (90 SHORT)	-------	1
4	FITTING - 3/4" M-NPR/ 3/4" M-JIC (90)	070202	2
5	FILTER INLINE 3000 PSI - 15GPM	SEE ORDER LIST	1
6	HOSE ASSEMBLY- 3/4" HIGH PRESSURE HOSE (2 WIRE BRAID, RUBBER JACKET	100R2 TYPE AT	3'
	W/END FITTINGS 3/4" F-JIC	--------	1
	3/4" F-JIC (90 SHORT)	--------	1
7	FITTING - 3/4 M-NPT - 3/4 M-JIC	070102	2
8	CONSTANT VOLUME PRIORITY FLOW DIVIDER VALVE (PRESSURE REDUCING)	SEE ORDER LIST	1
9	HOSE ASSEMBLY - 3/4" HIGH PRESSURE HOSE	100R2 TYPE AT	3'
	(2 WIRE BRAID - RUBBER JACKET)	--------	1
	W/END FITTINGS 3/4 F-JIC	---------	1
	3/4 F-JIC (90 SHORT)		
10	VALVE, 3 POS, 4 WAY, DIRECTIONAL CONTROL	SEE ORDER LIST	1
	W/HYDRAULIC REMOTE AND MANUAL HANDLE OVERRIDE		1
11	FITTING - 3/4 M-ORING/ 3/4 M-JIC (90)	070220	2
12	HOSE ASSEMBLY - 3/4" MEDIUM PRESSURE	100R5 TYPE	3,5'
	1 WIRE BRAID, RUBBER JACKET	WITH RUBBER COVER	
	W/END FITTINGS 3/4 F-JIC	-------	1
	3/4 F-JIC (90 LONG)	--------	1
13	FITTING - 1/2 M-NPT/ 3/4 M-JIC	070102	6
14	IN LINE RELIEF VALVE - 1500 PSI	SEE ORDER LIST	2
15	FITTING - 1/2" M-NPT/ 1/2" M-MPT (NIPPLE)	140137	2
16	FITTING - 1/2" F-NPT CROSS	140538	1

17	HOSE ASSEMBLY - 3/4" MEDIUM PRESSURE	100R5 TYPE	2.5'
	(1 WIRE BRAID - RUBBER JACKET)	WITH RUBBER COVER	
	W/END FITTINGS 3/4 F- JIC	--------	1
	3/4 F-JIC (90 SHORT)	--------	1
18	FITTING - SWIVEL NUT BRANCH TEE	070433	1
	3/4" M-JIC (2 ENDS) 3/4" F-JIC (BRANCH)		
19	FITTING - 5/8" M-ORING/ 3/4" M-JIC	0701225	2
20	HOSE ASSEMBLIES-3/4" HIGH PRESSURE (2 HOSE)	100R2 TYPE AT	7'
	(2 WIRE BRAID - RUBBER JACKET)	---------	2
	W/END FITTINGS 3/4 F-JIC	----------	2
	3/4" F-JIC (90 SHORT)		
21	HOSE ASSEMBLIES-3/4" HIGH PRESSURE (2 HOSES)	100R2 TYPE AT	14'
	(2 WIRE BRAID - RUBBER JACKET)	----------	2
	W/END FITTINGS-3/4 F-JIC	----------	2
	3/4 F-JIC (90 SHORT)		
22	FITTING - 3/4 F-NPT/ 3/4 F-JIC	070703	4
23	TUBING ASSEMBLY CONSISTING OF:	----------	
	(a) STEEL TUBING-1"OD.095 WALL THICKNESS(13FT)	----------	2
	(b) FERULOK FITTING-1"FLARELESS TUBE/ 3/4 M-NPT	080102	4
	(c) STAUFF 1" TUBE CLAMPS	----------	6(MIN)
24	HOSE ASSEMBLIES-3/4" HIGH PRESSURE (2 HOSES)	100R2 TYPE AT	6'
	(2 WIRE BRAID - RUBBER JACKET)	----------	2
	W/END FITTINGS-3/4" F-JIC	----------	2
	3/4 F-JIC (90 SHORT)		
25	FITTING-1" M-NPT/ 3/4 M-JIC	070102	2
26	FITTING-1" M-NPT/ 1" F-NPT 90	140239	2
27	SWIVEL ASSEMBLY WITH 1" F-NPT PORTS	PART OF RUDOMATIC MODEL 630 HOSE/TAGLINE SYSTEM SEE ORDER LIST	1
28	FITTING-1" M-NPT/ 3/4 F-NPT (REDUCER BUSHING)	140140	2
29	3/4" M-NPT/ 3/4 M-JIC (90)	070202	2
30	HOSE ASSEMBLIES 1/2" HIGH PRESSURE HOSE (2 HOSES)	100R2 TYPE AT	112.5'
	(2 WIRE BRAID, RUBBER COVER)	----------	2
	END FITTINGS 3/4" F-JIC	----------	2
	1/2" M-NPT		

31	FITTING-SELF SEALING COUPLER W/1/2" F-NPT THREAD AND DUST PLUG	----------	2
32	FITTING-SELF SEALING NIPPLE W/ 1/2 F-NPT THREAD AND DUST CAP	----------	2
33	FITTING - 1/2 NPT NIPPLE	140137	2
34	SWIVEL FITTING-1/2 M-NPT STEM/ 1/2 F-NPSM ARM	----------	2
35	SWIVEL ASSEMBLY	SEE ORDER LIST	1
36	FITTING 1/2 M-NPT/ 1/2 F-NPSM (90)	140230	2
37	HOSE ASSEMBLIES - 1/2" HIGH PRESSURE HOSE (TWO WIRE BRAID, RUBBER JACKET)	100R2 TYPE AT	6'
	W/END FITTINGS 1/2 M-NPT	----------	2
	1/2 M-NPT	----------	2
38	FITTING 5/8" M-ORING - 1/2 F-NPSM	----------	2
39	HYDRAULIC MOTOR (ROSS MAB 08)	PART OF MARCO POWER BLOCK MODEL 19B (MOTOR: ROSS TORQ MOTOR MAB 08, STANDARD MOUNT W/ 6-B SPLINE SHAFT SEE ORDER LIST	1

MATERIALS ORDER LIST

QTY	DESCRIPTION	PARKER #	AEROQUIP #	DAYCO #	WEATHER HEAD #	EST UNIT PRICE	EST TOTAL PRICE	REF SCHEMATIC
	FITTINGS/ADAPTERS							(LP SYSTEM)
2	3/8 M-ORING/ 3/8 M-JIC (90)	2503-6-6	2062-6-6S	6801-6-6	C5515x6	3.20	6.40	1
4	3/8 M-ORING/ 3/8 M-JIC	8503-6-6	202702-6-6S	6400-6	C5315	1.00	4.00	3
1	3/8 M-NPT/ 3/8 M-JIC	8103-6-6	2021-6-6S	2404-6-6	C5205x6x6	1.00	1.00	8
1	1/2 M - NPT/ 3/8 M-JIC	8103-8-6	2021-8-6S	2404-6-8	C5205x6x8	1.40	1.40	7
1	SWIVEL NUT BRANCH TEE (3/8 M-JIC ENDS/ 3/8 F-JIC BRANCH)	393-T-6-6	203101-6-6S	6600-6	C5707x6	4.00	4.00	10
1	REDUCER-3/4 F-JIC/ 3/8 M-JIC	TRBTX-12-6	221501-12-6S	----------	----------	5.25	5.25	11
								(HP SYSTEM)
1	3/4 ORING PLUG	85CP-12	900598-12S	6408-12	C5315x10 &C5129x10	1.30	1.30	1
1	5/8 M-ORING/ 3/4 M-JIC (90)	2503-10-12	2062-10-12S	6801-12-10	C5515x12x10	4.50	4.50	2
4	3/4 M-ORING/ 3/4 M-JIC (90)	2503-12-12	202702-12-12S	6801-12	C5515x12	6.75	27.00	4,11
2	3/4 M-NPT/ 3/4 M-JIC	8103-12-12	2021-12-12S	2404-12-12	C5205x12	2.00	4.00	7
6	1/2 M-NPT/ 3/4 M-JIC	8103-8-12	2021-8-12S	2404-12-8	C5205x12x8	2.40	14.40	13
	NIPPLE-1/2 NPT	8101-8-8	2083-8-8S	5404-8-8	C3069x8	1.40	2.80	15,33
1	PIPE CROSS - 1/2 F-NPT	822X-8	2089-8-8S	5652-8-8	----------	14.00	14.00	16
1	SWIVEL NUT BRANCH TEE (3/4 M-JIC ENDS/ 3/4 F-JIC BRANCH)	393T-12	203101-12-12S	6600-12	C5707x12	8.00	8.00	18
2	5/8 M-ORING/ 3/4 M-JIC	8503-10-12	202702-10-12S	6400-12-10	C5315x12x10	2.50	5.00	19
4	3/4 F-NPT/ 3/4 M-JIC	8203-12-12	2022-12-12S	2405-12-12	C5255x12	1.50	6.00	22
2	1" M-NPT/ 3/4 M-JIC	8103-16-12	2021-16-12S	2404-12-16	C5205x12x16	3.25	6.50	25
2	STREET ELBOW - 1" (1" M-NPT/ 1" F-NPT (90))	2102-16-16 OR CDS-1	2089-16-16S	5502-16-16	C3409x16	10.50	21.50	26
2	BUSHING-1" M-NPT/ 3/4 F-NPT	8102-16-12	2081-16-12S	5406-16-12	C3109x16x12	2.50	5.00	28
2	3/4 M-NPT/ 3/4 M-JIC (90)	2103-12-12	2024-12-12S	2501-12-12	C5405x12	4.75	9.50	29
2	SWIVEL - 1/2 M-NPT STEM/ 1/2 F-NPSM ARM	52107-8-8	BDSS000-00	----------	----------	20.00	40.00	34
2	1/2 M-NPT/ 1/2 F-NPSM (90)	2107-8-8	2047-8-8S	55-8-8	9405x8x8	3.25	6.50	36
2	5/8 M-ORING/ 1/2 F-NPSM	8507-10-8	2066-8-10S	59-10-8	9315x10x8	3.75	7.50	38
	QUIK DISCONNECT COUPLINGS							
2	1/2 F-NPT SELF-SEALING COUPLER	H4-62	5601-8-10S	801-P	----------	17.50	35.00	31
2	1/2 F-NPT SELF-SEALING NIPPLE	H4-63	5602-8-10S	802-P	----------	12.50	25.00	32
2	DUST PLUG FOR COUPLER	H4-65	5602-8-10S	DC803	----------	2.50	5.00	31
2	DUST CAP FOR NIPPLE	H4-66	5647-8-10S	DC804	----------	1.00	2.00	32
	HOSE AND HOSE FITTINGS - MEDIUM PRESSURE							(LP SYSTEM)
15'	3/8" I.D 1 WIRE BRAID HOSE W/RUBBER COVER	221-6	2651-6	6RD	H10406	4.00/FT	60.00	2,5,6,9
7	3/8 F-JIC	20620-6-6	411-6S	6FJ-6DN	----------	4.50	31.50	2,5,6,9
3	3/8 F-JIC (90 SHORT)	23920-6-6	190261-6S	6PJ9-6DN	----------	8.00	24.00	2,5,6,9
								(HP SYSTEM)
6'	3/4"I.D 1 WIRE BRAID HOSE W/RUBBER COVER	221-12	2651-12	12RD	H10412	5.00/FT	30.00	12,17
2	3/4 F-JIC	20620-12-12	411-12S	12FJ-12DN	----------	9.00	18.00	12,17
1	3/4 F-JIC (90 SHORT)	23920-12-12	190261-12S	12PJ9-12DN	----------	12.50	12.50	12
1	3/4 F-JIC (90 LONG)	24120-12-12	190260-12S	----------	----------	17.00	17.00	17

QTY	DESCRIPTION	PARKER#	AEROQUIP #	DAYCO#	WEATHER HEAD#	EST UNIT PRICE	EST TOTAL PRICE	REF SCHEMATIC
	HOSE AND HOSE FITTINGS - HIGH PRESSURE							
40'	3/4" I.D 2 WIRE BRAID HOSE W/RUBBER COVER (3/4" HOSE FITTINGS)	301-12	1509-12	12BX	H42512	6.00/FT	240.00	3,6,9,12,17 20,21,24
10	3/4 F-JIC	20630-12-12	4721-125	12FS-125A	42512N-612	9.00	90.00	3,6,9,12,17 20,21,24
9	3/4 F-JIC (90 SHORT)	23930-12-12	190264-125	12PJ9-12SA	42512N-672	12.50	112.50	3,6,9,17,20 21,24
1	3/4 F-JIC (90 LONG)	24130-12-12	190263-125	-------	42512N-652	17.00	17.00	12
130'	1/2" I.D 2 WIRE BRAID HOSE W/RUBBER COVER (1/2" HOSE FITTINGS)	301-8	1509-8	8BX	H42508	4.50/FT	585.00	30,37
1	3/4 F-JIC	20630-12-8	4721-12-8S	12FS-8SA	(W/C5255x12x8) 42508N-108	7.00	7.00	30
3	1/2" M-NPT	20130-8-8	4722-8-8S	8NP-8SA	42508N-108	4.75	14.25	30,37
	TUBING AND FITTINGS							
2	TUBING, STEEL, 1"O.D (.095 WALL)	13 FT EA.	--------	---------	--------	3.50/FT	91.00	23
4	FLARELESS TUBE FITTING (1"TUBING/ 3/4 M-NPT)	FBU-16-12	------	-------	---------	8.00	32.00	23
6	1" TUBE CLAMPS (STAUFF) (INCLUDES MOUNTING PLATE, SPLIT CLAMP HALVES AND CAPSCREWS)	----------	--------	--------	----------	3.00	18.00	23
		FITTINGS AND HOSES TOTAL EST PRICE					$1668.80	

HYDRAULIC VALVES AND ATTACHMENTS

QTY	COMPONENT	DESCRIPTION/PART #	MANUFACTURER	EST UNIT PRICE	EST TOTAL PRICE	REF SCHEMATIC
						(LP SYSTEM)
1	REMOTE CONTOLLER, HYDRAULIC	GRESEN SECTIONAL HYDRAULIC CONTOLLER-1 (ONE) SECTION WITH STANDARD HANDLE, SPRING RETURN TO NEUTRAL, SAE 6 PORTS, PRESSURE 55-305 PSI, INVERTED BRACKET-MODEL # HCS	GRESEN MFG. CO. P.O. BOX 1313 MINNEAPOLOS, MINN. 55440 (612) 623-1960 (AVAILABLE THROUGH LOCAL GRESEN HYDRAULIC DISTRIBUTOR)	500.00	500.00	4
		PITMAN VALVE ASSEMBLY CONSISTING OF PART #'S: 604-04-0004 (1 EACH) 610-04-0002 (1 EACH) 610-04-0001 (1 EACH)	PITMAN MFG. CO. INC. 7400 WOODBINE AVE. MARKHAM. ONTARIO L3RIA6 (416) 475-1211 (AVAILABLE THROUGH LOCAL PITMAN CRANE DEALER)	800.00	800.00	4
						(HP SYSTEM)
1	FILTER, INLINE, 10 MICRON	SCHROEDER FILTER 3000PSI, 15GPM, INLINE 10 MICR FILTER W/SAE 12 (3/4"-ORING PORTS) AND COLOR CODED VISUAL DIRT ALARM PART # MF30-IN10-S-D	SCHROEDER BROS. CORP. P.O. BOX 625 VIENNA, VIRGINIA 22180 (703) 937-4563	200.00	200.00	5
1	VALVE, PROIRITY FLOW DIVIDER (PRESSURE REDUCING FOR CONTROLLED FLOW PORT)	GRESEN CONSTANT FLOW PRIORITY FLOW VALVE MODEL # CFD-75-3-300	GRESEN MRG. CO. P.O. BOX 1313 MINNEAPOLIS, MINN. 55440 (612) 623-1960 (AVAILABLE THROUGH LOCAL GRESEN HYDRAULICS DISTRIBUTOR)	120.00	120.00	8
NOTE:	IF AMBAC FLOW REGULATOR USED, ITEMS 8, 9, AND 10 IN LOW PRESSURE SYSTEM NOT REQUIRED	AMBAC PRESSURE COMPENSATED PRIORITY FLOW REGUALTOR MODEL # 13-A32-F-6	AMBAC, INDUSTRIES, INC. FLUID POWERS SYSTEMS DIV. 511 S. GLENN AVE. WHEELING, ILL. 60090 (312) 459-2800			

HYDRAULIC VALVES AND ATTACHMENTS

QTY	COMPONENT	DESCRIPTION/PART #	MANUFACTURER	EST UNIT PRICE	EST TOTAL PRICE	REF SCHEMATIC
1	VALVE, DIRECTIONAL, CONTROL	GRESEN DIRECTIONAL CONTROL VALVE-1 (ONE) OPEN CENTER MOTORING SPOOL VALVE SECTION WITH ADJUSTABLE MAIN RELIEF IN INLET COVER (0-3000 PSI), POWER BEYOND SLEEVE IN OUTLET COVER, WITH HYDRAULIC REMOTE VALVE AND MANUAL OVERRIDE OPTION GRESEN MODEL # V20-YE-F4-HRH-RT51A-3000	GRESEN MFG. CO. P.O. BOX 1313 MINNE APPOLIS, MINN. 55440 (612) 623-1960 (AVAIABLE THROUGH LOCAL GRESEN HYDRAULICS DISTRIBUTOR)	700.00	700.00	10
NOTE:	VALVE ASSEMBLY INCLUDES VALVE PARTS, ORINGS, SEALS CAPSCREWS, AND NUTS	PITMAN VALVE ASSEMBLY CONSISTING OF PART #'S: 610-02-0027 (1 EACH) 610-02-0028 (1 EACH) 610-02-0029 (1 EACH) 610-02-0030 (1 EACH)	PITMAN MFG. CO. INC. 7400 WOODBINE AVE. MARKHAM, ONTARIO L3R1A6 (416) 475-1211 (AVAILABLE THROUGH LOCAL PITMAN CRANE DEALER)	1000.00	1000.00	
2	VALVE, RELIEF, INLINE	GRESEN INLINE RELIEF VALVE SET AT 1500 PSI MODEL # JL-50-HP-1500	GRESEN MFG. CO. P.O. BOX 1313 MINNEAPOLIS, MINN, 55440 (612) 623-1960 (AVAILABLE THROUGH LOCAL GRESEN HYDRAULICS DISTRIBUTOR)	50.00	100.00	14
1	HOSE REEL, DUAL, SPRING RETRACT, WITH HIGH PRESSURE SWIVEL ASSEMBLY	RUDOMATIC-COMBINATION HYDRAULIC HOSE REEL AND TAG LINE, SINGLE BARREL, DOUBLE ACTION SWIVEL WITH FAIRLEAD ASSEMBLY MODEL # 630	RUDOMATIC, INC. 2131 EAST 25th ST. LOS ANGLES, CALIF. 90058 (213) 582-6314	2500.00	2500.00	27
1	SWIVEL ASSEMBLY, DUAL, LOAD CARRYING	MOBILE EQUIPMENT CO. DUAL HYDRAULIC LOAD CARRYING SWIVEL ASSEMBLY MODEL # LCS-8	MOBILE EQUIPMENT CO. 3610 GILMORE AVE. BAKERSFIELD. CALIF. 93308 (805) 327-8476	2000.00	2000.00	35
1	BLOCK, HYDRAULIC POWERED, RUBBER SHEAVE	MARCO PURETIC POWER BLOCK-MODEL # B19B/B919B WITH POWER GRIP (see Figure A-3, Page A-30)	MARCO SEATTLE 2300 W. COMMODORE SEATTLE, WASH. 98199 (206) 285-3200 (ALSO AVAILABLE THROUGH REGIONAL MARCO DEALERS)	7200.00	7200.00	39
		HYDRAULIC COMPONENTS TOTAL EST. PRICE			$13320.-$13620.	

Parts List

1. M 1000-82
2. M 1010-82
3. M 1015-82
4. M 1020-82
5. M 1025-82
6. M 1030-82
7. M 1035-82
8. M 1040-82
9. M 1045-82
10. M 1050-82

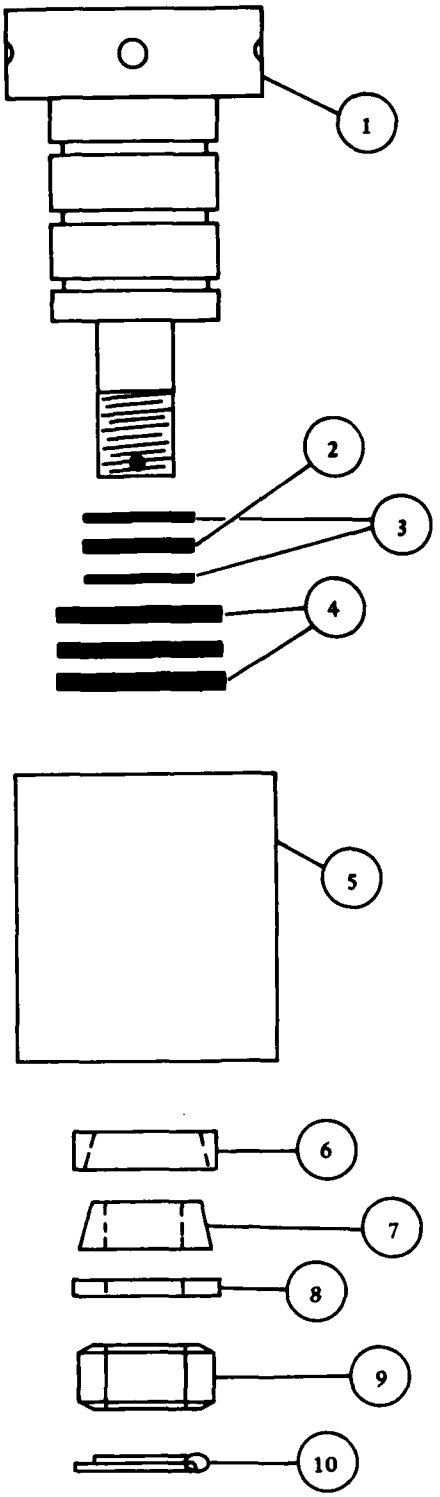

Figure B-1. Load bearing double swivel (Pat. Pending, Mobile Equipment Co., 3610 Gilmore Ave., Bakersfield, California 93308).

Appendix C

RELIABILITY, AVAILABILITY, MAINTAINABILITY OF SHORE-TO-SHIP ELECTRICAL POWER CABLE HANDLING EQUIPMENT

CONTENTS

LIST OF TABLES

LIST OF FIGURES

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1.0 PURPOSE

The purpose of this document is to document the results of a top-level Reliability, Availability, Maintainability (RAM) and logistics engineering assessment performed on the NCEL prototype shore-to-ship electrical power cable handling equipment for use in providing shore electrical service to pierside ships at Navy ports. The cable handling equipment consists of a modified commercial hydraulic, truck mounted, telescoping crane with a hydraulic power block attached.

2.0 SCOPE

The RAM and logistics engineering assessment consisted of a review of all technical documentation that included:

(1) Naval Civil Engineering Laboratory (NCEL) Technical Memorandum M-64-81-08: FY-81 Field Testing of Shore-to-Ship Electrical Power Cable Handling Equipment, by D.E. Dahle, September 1981.

(2) Enclosure (1) to NCEL ltr. Ser 817 of 28 May 1982 - "Naval Station, Norfolk Field Test Summary on Prototype Cable Handling System".

(3) Enclosure (1) to NCEL ltr. Ser 1259 of 4 Aug 1982 - "Procedures and Data Forms for Time Study and Evaluation of Shore-to-Ship Cable Handling Equipment".

(4) Naval Station, San Diego Field Test Summary of Prototype Cable Handling System.

(5) Pitman Division, A.B. Chance Company Operators Maintenance and Parts Manual for Hydralift Model HL-1064.

(6) Marco Seattle. Instruction Manual for Model 19B-MAB-08 Puretic Power Block.

(7) NCEL. Draft schematics of hydraulic system modification including parts lists for prototype cable handling system.

The assessment shall be limited to the mounted crane unit and modifications to the crane (commercial truck not included) as described above.

Site visitation at Naval Stations, San Diego and Norfolk provided additional information along with direct conversation with NCEL project engineers.

Current reliability, maintainability, and logistics standards and specifications were also reviewed for application to the cable handling equipment. These include:

(1) MIL-HDBK-217C, Reliability Prediction

(2) MIL-HDBK-472, Maintainability Prediction

(3) MIL-STD-1629, Failure Mode and Effects Analysis

(4) MIL-STD-1388, Logistic Support Analysis

(5) Reliability Engineering, ARINC Research Corporation, 1964

(6) Maintainability Engineering, Blanchard & Lowery, 1969

(7) Logistics Engineering and Management, Blanchard 2nd Edition, 1981

(8) Life Cycle Cost, Blanchard, 1978

3.0 TECHNICAL APPROACH

In performing both the RAM and logistics assessment of the telescopic crane with hydraulic-powered block, a detailed review was conducted on the manufacturers operating and maintenance instructions. From this review a top-level functional flow diagram was developed. This diagram provides the basis for all subsequent reliability, maintainability, and logistics assessment.

3.1 Functional Flow Diagram and Description

The telescopic crane and hydraulic power block being evaluated is mounted on a flatbed truck. The major components of the crane and block are:

(1) Mainframe - a welded steel structure that mounts on to the bed of the truck and supports the rotating turret, dual control station, outriggers, and operator platforms.

(2) Turret Assembly - serves as the boom base pivot and elevation cylinder pivot. Rotation is powered by a bidirectional hydraulic motor (located within the turret) driving a 25:1 worm reduction gearbox.

(3) Boom - the telescopic boom is a 3-stage assembly in which the 2nd and 3rd stages (i.e., cylinders) are hydraulically extended.

(4) Cylinders - the cylinders include the topping cylinder which is used to elevate the boom and the four outrigger cylinders which are used to extend and retract the main (2) and auxiliary (2) outriggers that establish the base for crane operations.

(5) Hydraulic-powered block - a rubber covered sheave which rotates within a supporting frame on antifriction bearings. A ring gear is attached to the sheave and is driven by a pinion on the shaft of a hydraulic motor. The block is attached to the boom tip and is open top and V-grooved.

Power to operate the crane is provided from a power takeoff (PTO) that is mounted in the truck chassis drive line. The PTO must be engaged to deliver power to the tandem hydraulic pump to operate the various hydraulically controlled crane functions. When engaged to the hydraulic pump, the pump takes suction on the reservoir and delivers hydraulic fluid to the control valves. Figure 1 below shows a simplified hydraulic schematic.

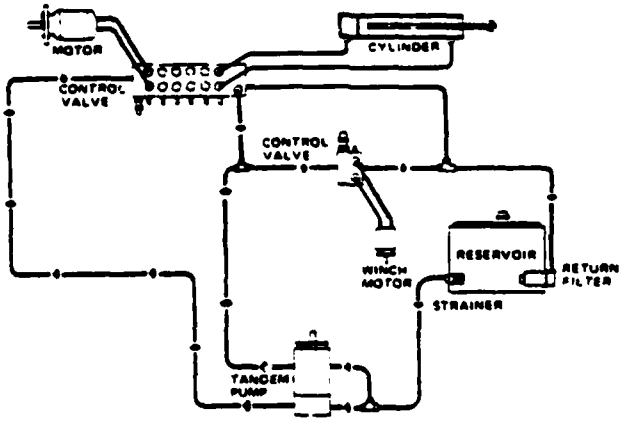


Figure 1. Simplified Hydraulic Schematic

Fluid from the tandem pump is routed to the control valves which can operate the motor to turn the turret, the cylinders for raising/lowering and telescoping the boom, and raising/lowering the outriggers, and the motors for operating the winch and power block.

This means that whenever the hydraulic pump is operating, oil is flowing through the hydraulic pressure and return lines. When a control is opened, the flow of oil through the open center of the valve is blocked and diverted to a predetermined port in the valve, which provides passage of the oil to the cylinder or motor involved. As long as the control is left open to perform work, this working pressure will be sustained. The hydraulic system is an "open center" type. The hydraulic system also includes two filters, both mounted in the hydraulic oil reservoir, to remove contaminates from the hydraulic oil. A magnetic separator (i.e., strainer) is located in the pump suction line and a micronic cellulose cartridge filter (10 micron) in the return line.

Functional flow diagram of the entire crane and power block is shown in Figure 2 and the following discussion pertains to the flow diagram.

The PTO provides power to the tandem pump which supplies hydraulic fluid to the flow divider valve via the power block valve and selector valve. The flow divider valve diverts some of the hydraulic fluid (low pressure, low flowrate) to the pilot valve bank and two additional pilot valves (winch and power block), with the excess fluid continuing on to the winch manifold, relief and control valves. The selector valve directs hydraulic fluid to either the boom valve bank, or to the outrigger manifold and relief valve, and associated outrigger control valves. As the control valves or corresponding pilot valves are opened or closed, the various motors and/or cylinders are operated.

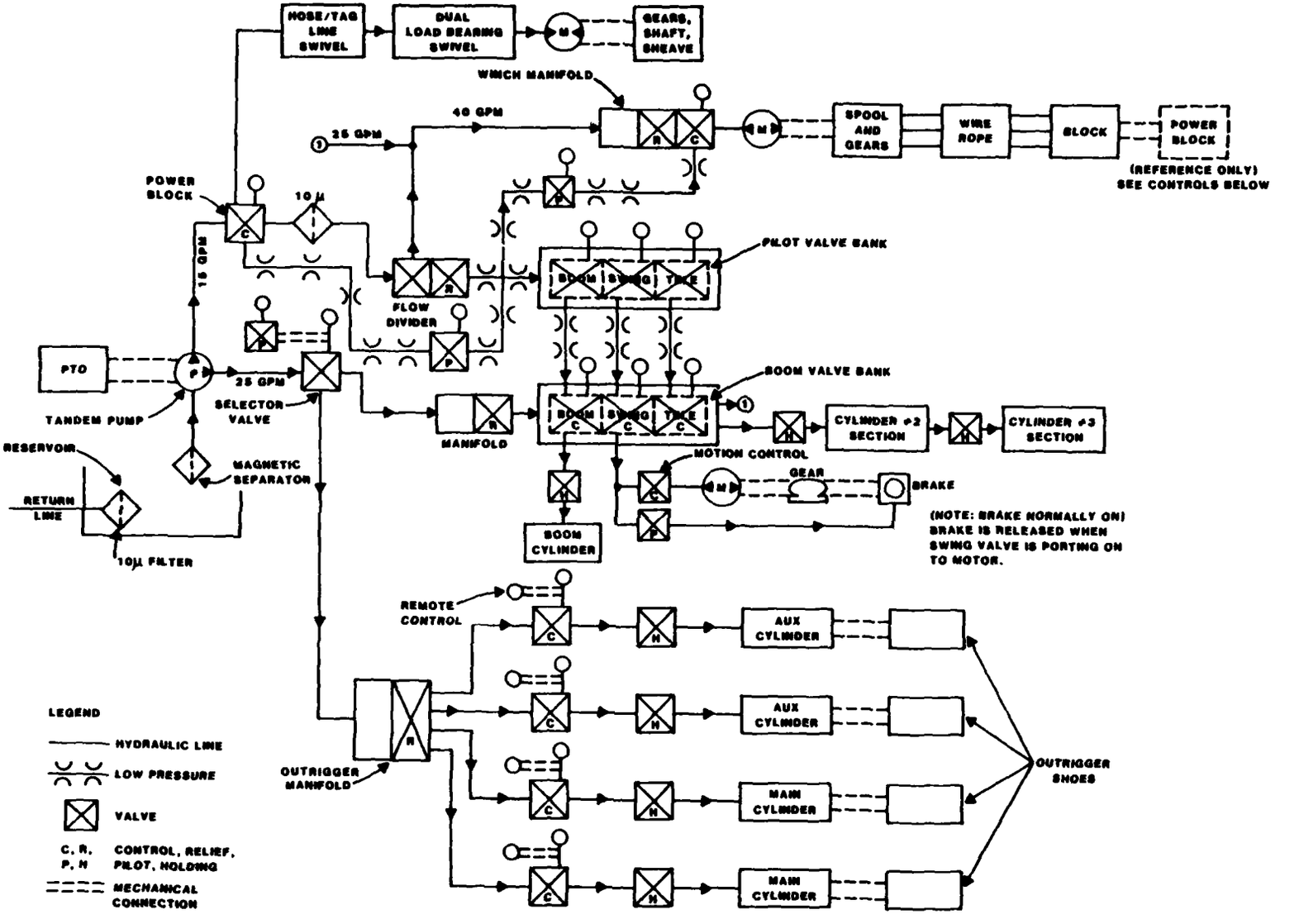


Figure 2. Cable elevation unit and power block functional flow diagram.

3.2 Reliability Block Diagram

The reliability block diagram for the crane and power block was developed from the functional block diagram of Figure 2, and using the guidance delineated in MIL-HDBK-217C Appendix A.

A prerequisite for developing the reliability block diagram is understanding the definition of the crane and power block as related to the definitions of reliability.

System/equipment reliability is defined as the probability of performing a specified function or mission under certain conditions for a specified time.

The reliability block diagram is a pictorial form of a statement of what is required for mission success. It provides the series and parallel paths depicting the equipment required for success.

An understanding of the operations, use, and constraints of the crane and power block was required for developing the functional flow diagram and supporting system description. It was determined for both the crane and power block functions that all the equipment (i.e., assemblies, units, components) for each function would be required for system success. There is some redundancy in the controls for boom elevation and telescoping, swing, and power block operations, but only partial. Therefore, the entire equipment is required for system success resulting in a completely series reliability block diagram. Figure 3 provides the reliability block diagram for the crane and power block functions.

The next step is to develop the reliability model (i.e., mathematical representation of the reliability block diagram).

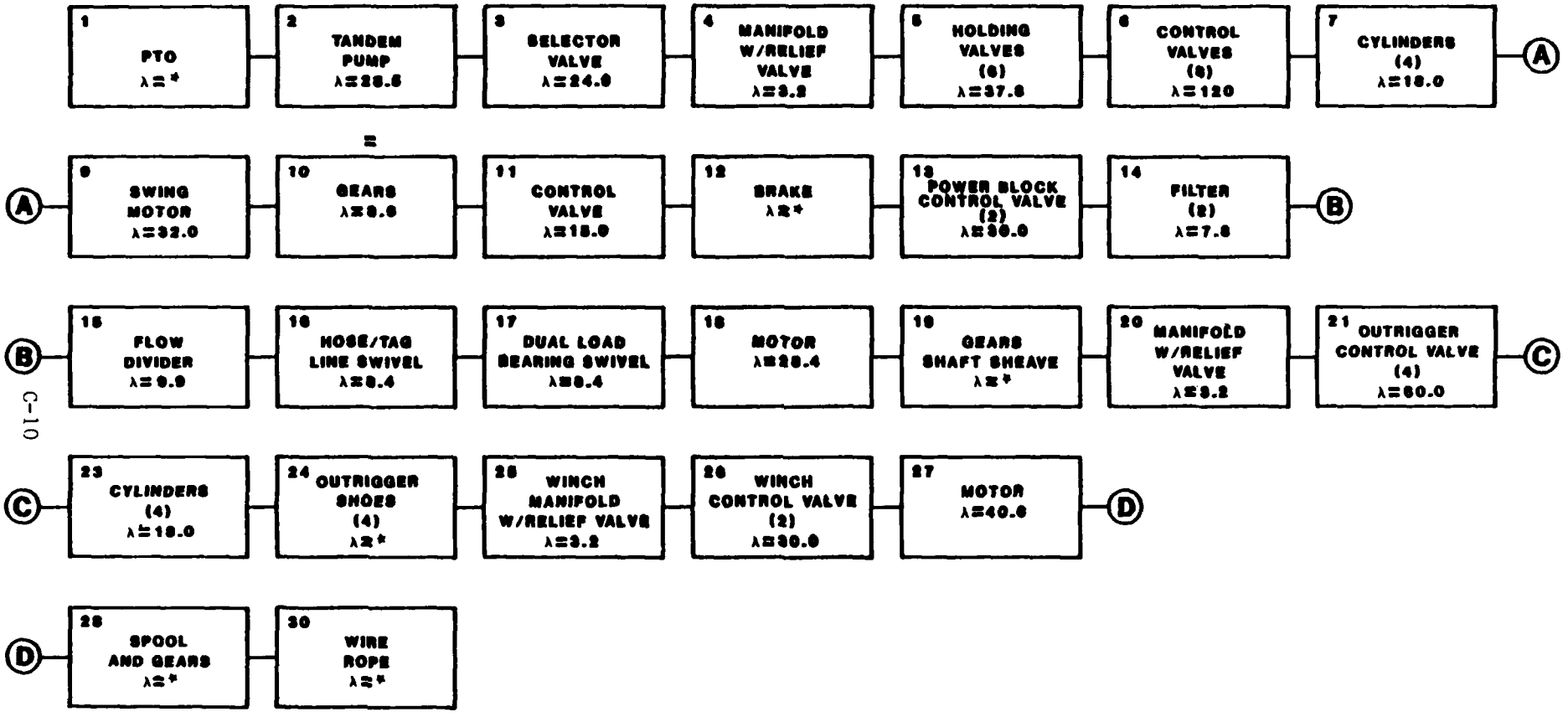


Figure 3. Reliability Block Diagram

Since all equipment is in series, the probability of system success for the crane and power block is equal to the product of the probability of success for each individual equipment, assembly, or component. Since reliability is a probability of success, the reliability for each block is determined and multiplied. The reliability for each block is determined from the expression;

$$R = e^{-\lambda t} \tag{1}$$

where,

R = reliability (expressed as a decimal)

e = base of naperian log system (2.718)

λ = lambda or failure rate (normally expressed in failures/10^6 hours)

t = mission time (normally expressed in hours)

The probability for system success of the crane and power block is

$$P_{ss} = R_1 \times R_2 \times \ldots R_{30} \tag{2}$$

where,

P_{ss} = probability of system success

$R_1 - R_{30}$ = reliability of each block

Since all the major components are reduced to a series path, equation 2 can be simplified to determine the reliability. The individual failure rates are added to determine the total failure rate for the crane and power block functions. The failure rate for these functions was 486.9 failures/10^6 hours or 0.5 failures/year based on 1040 hours of operation per year. By solving the expression in equation 1, the reliability is determined.

The failure rate (λ) for each block was determined using historical data from various Navy and Department of Defense data sources. These sources are listed in section 2. The failures and associated sources of each block are discussed in section 3.5. Each failure rate is annotated on the respective block.

3.3 Failure Modes and Effect Analysis (FMEA)

An FMEA was performed on the crane and power block functions. The FMEA evaluates the reliability of the design by postulating probable failure symptoms (modes) and determining the resulting effects of that failure. In addition, the basic cause of each failure and the design recommendations to circumvent or mitigate each are provided. MIL-STD-1629 provided the basic format for the report.

A thorough understanding of the basic design and operation of the crane power block subsystems is a prerequisite to conducting the system-level FMEA. The functional flow diagram and supporting system description in section 3.1 provides the basis for the FMEA.

In performing the system-level FMEA and compiling the results on the attached worksheet, the following criteria were used. Each area discussed below refers to the identical column on the worksheet.

(1) Output Specification/Functional Description

General subsystem requirements were used to provide the output specification/functional description for the system being analyzed.

(2) Failure Symptom

A serial number is provided for identification of the failure symptom and possible cause. The numbers are assigned sequentially. The failure symptom description indicates the different ways in which each output specification, or functional description deviates from the required performance.

(3) Possible Causes

This is the possible cause associated with each postulated failure symptom identified in (2).

(4) Failure Detection Method

The failure detection method is used to describe the features that are incorporated in the design through which occurrence of a failure mode is recognized. The word none indicates that there is no direct or indirect method of failure detection.

(5) Effect of Failure

The effect of failure will be the consequences of each assumed failure symptom on the operation, function, and/or status of the system being analyzed. The effect of failure describes the results of the failure symptom on the system being evaluated.

(6) Existing Compensation Provision

An existing compensation provision is an integral part of the design that either circumvents or mitigates the effect of the postulated failure. Compensating provisions include redundant items that allow continued and safe operation if one or more items fail, alternate modes of operation, and safety or relief devices.

(7) Classification of Failure

The following failure definitions were provided in the Statement of Work.

(a) Level 1 Minor. Failure mode characterized by the following condition:

No effect on the crane or power block operation.

(b) Level 2 Major. Failure mode characterized by the following condition:

Degradation on the crane or power block operation.

(c) Level 3 Critical. Failure mode characterized by the following condition:

Severe reduction on the crane or power block operation.

(d) Level 4 Catastrophic. Failure mode characterized by the following conditions:

1. The crane or power block is totally inoperative.

2. An unsafe condition that could cause bodily harm to the operator.

(8) Failure Probability

Failure probability is provided for each possible cause for all postulated, identified failure symptoms. Failure probabilities are based on the complexity of the equipment, usage and application within the subsystem, and historical data. Generic terms such as very low, low, medium, and high are used to describe each failure probability.

(9) Remarks

Recommended improvements are provided to either reduce the classification of failure or provide optimum compensating provision or to improve maintenance and operation procedures.

An FMEA has been performed on both the crane and power block functions, and an overall hydraulic FMEA.

The results of the FMEA are contained on the following worksheets.

SYSTEM _____

SUBSYSTEM Cable Elevation Unit

EQUIPMENT Telescoping Boom

F M E A

FAILURE MODE AND EFFECT ANALYSIS

SHIP-TO-SHORE CABLE ELEVATION UNIT AND POWER BLOCK

DATE September 1983

1. OUTPUT SPECIFICATION FUNCTIONAL DESCRIPTION	2. FAILURE SYMPTOM		3. POSSIBLE CAUSES	4. FAILURE DETECTION METHOD	5. EFFECT OF FAILURE	6. EXISTING COMPENSATING PROVISION	7. CLASS OF FAILURE	8. FAIL PROB	9. REMARKS
	SERIAL NUMBER	DESCRIPTION							
To telescope boom.	001	Unable to telescope boom.	Selector valve faulty.	Indirect--no response to control.	Boom does not telescope.	None.	Critical	Very low	
			Telescoping control valve faulty.	Indirect--no response to control.	Boom does not telescope.	None.	Critical	Very low	
			Holding valve cylinder #2 faulty.	Indirect--no response to control.	Boom does not telescope.	None.	Critical	Very low	
			Cylinder #2 leaks.	Indirect--no response to control.	Boom does not telescope.	None.	Critical	Very low	
			Holding valve cylinder #3 faulty.	Indirect--no response to control.	Boom does not telescope.	None.	Critical	Very low	
			Cylinder #3 leaks.	Indirect--no response to control.	Boom does not telescope.	None.	Critical	Very low	
			Relief valve fails to open.	Indirect--no response to control.	Boom does not telescope.	None.	Critical	Very low	
			Loss of hydraulic pressure.	Indirect--no response to control.	Boom does not telescope.	Holding valves.	Catastrophic	Low	

SYSTEM _____

SUBSYSTEM Cable Elevation Unit

EQUIPMENT Winch

F M E A

FAILURE MODE AND EFFECT ANALYSIS

SHIP-TO-SHORE CABLE ELEVATION UNIT AND POWER BLOCK

DATE September 1983

1. OUTPUT SPECIFICATION FUNCTIONAL DESCRIPTION	2. FAILURE SYMPTOM		3. POSSIBLE CAUSES	4. FAILURE DETECTION METHOD	5. EFFECT OF FAILURE	6. EXISTING COMPENSATING PROVISION	7. CLASS OF FAILURE	8. FAIL PROB	9. REMARKS
	SERIAL NUMBER	DESCRIPTION							
To operate winch.	001	Unable to operate winch.	Flow divider valve faulty.	Indirect--winch does not operate.	Hook block does not raise or lower.	None.	Critical	Very low	
			Manifold plugged.	Indirect--winch does not operate.	Hook block does not raise or lower.	None.	Critical	Very low	
			Relief valve stays open.	Indirect--winch does not operate.	Hook block does not raise or lower.	None.	Critical	Very low	
			Control valve faulty.	Indirect--winch does not operate.	Hook block does not raise or lower.	None.	Critical	Very low	
			Motor faulty.	Indirect--winch does not operate.	Hook block does not raise or lower.	None.	Critical	Very low	
			Lack of hydraulic pressure.	Indirect--winch does not operate.	Hook block does not raise or lower.	None.	Catastrophic	Low	

SYSTEM _____

SUBSYSTEM Cable Elevation Unit

EQUIPMENT Boom Elevation

F M E A

FAILURE MODE AND EFFECT ANALYSIS

SHIP-TO-SHORE CABLE ELEVATION UNIT AND POWER BLOCK

DATE September 1983

1. OUTPUT SPECIFICATION FUNCTIONAL DESCRIPTION	2. FAILURE SYMPTOM		3. POSSIBLE CAUSES	4. FAILURE DETECTION METHOD	5. EFFECT OF FAILURE	6. EXISTING COMPENSATING PROVISION	7. CLASS OF FAILURE	8. FAIL PROB	9. REMARKS
	SERIAL NUMBER	DESCRIPTION							
To raise or lower boom.	001	Unable to raise/lower boom.	Selector valve faulty.	Indirect--no response to control.	Boom does not raise or lower.	None.	Critical	Very low	
			Boom control valve faulty.	Indirect--no response to control.	Boom does not raise or lower.	Use remote valve.	Major	Very low	
	002	Unable to raise boom.	Leaky boom cylinder.	Indirect--no response to control.	Boom does not raise.	None.	Critical	Very low	
			Loss of hydraulic pressure.	Indirect--no response to control.	Boom does not raise.	None.	Critical	Low	
	003	Boom falls without control.	Loss of hydraulic pressure.	Indirect--boom falls without control.	Boom falls uncontrolled.	None.	Catastrophic	Low	
			Leaky boom cylinder.	Indirect--boom falls without control.	Boom falls uncontrolled.	None.	Catastrophic	Very low	

SYSTEM _____

SUBSYSTEM Cable Elevation Unit

EQUIPMENT Hydraulic Source

F M E A

FAILURE MODE AND EFFECT ANALYSIS

SHIP-TO-SHORE CABLE ELEVATION UNIT AND POWER BLOCK

DATE September 1983

1. OUTPUT SPECIFICATION FUNCTIONAL DESCRIPTION	2. FAILURE SYMPTOM		3. POSSIBLE CAUSES	4. FAILURE DETECTION METHOD	5. EFFECT OF FAILURE	6. EXISTING COMPENSATING PROVISION	7. CLASS OF FAILURE	8. FAIL PROB	9. REMARKS
	SERIAL NUMBER	DESCRIPTION							
To provide hydraulic pressure to the winch, boom elevation, swing, boom telescoping, outrigger, and power block functions.	001	Unable to provide hydraulic pressure.	PTO shaft broken.	Indirect--no functions respond.	Unable to perform winch, boom elevate or telescoping, swing, outrigger, and power block functions.	None.	Catastrophic	Very low	
			Tandem pump faulty.	Indirect--no functions respond.	Unable to perform winch, boom elevate or telescoping, swinch, outrigger, and power block functions.	None.	Catastrophic	Low	
			Clogged strainer.	Indirect--sluggish or no functions respond.	All or some functions perform sluggishly or not at all.	None.	Critical	Low	
			Clogged filter.	Indirect--sluggish or no functions respond.	All or some functions perform sluggishly or not at all.	None.	Critical	Low	

SYSTEM _____

SUBSYSTEM Cable Elevation Unit

EQUIPMENT Swing

F M E A

FAILURE MODE AND EFFECT ANALYSIS

SHIP-TO-SHORE CABLE ELEVATION UNIT AND POWER BLOCK

DATE September 1983

1. OUTPUT SPECIFICATION FUNCTIONAL DESCRIPTION	2. FAILURE SYMPTOM		3. POSSIBLE CAUSES	4. FAILURE DETECTION METHOD	5. EFFECT OF FAILURE	6. EXISTING COMPENSATING PROVISION	7. CLASS OF FAILURE	8. FAIL PROB	9. REMARKS
	SERIAL NUMBER	DESCRIPTION							
To swing crane.	001	Unable to swing crane.	Selector valve faulty.	Indirect--no response to control.	Crane does not swing.	None.	Critical	Very low	
			Swing valve faulty.	Indirect--no response to control.	Crane does not swing.	None.	Critical	Very low	
			Swing motor inoperative.	Indirect--no response to control.	Crane does not swing.	None	Critical	Very low	
			Loss of hydraulic pressure.	Indirect--no response to control.	Crane does not swing.	None	Catastrophic	Low	

SYSTEM _____

SUBSYSTEM Cable Elevation Unit

EQUIPMENT Outrigger

F M E A

FAILURE MODE AND EFFECT ANALYSIS

SHIP-TO-SHORE CABLE ELEVATION UNIT AND POWER BLOCK

DATE September 1983

1. OUTPUT SPECIFICATION FUNCTIONAL DESCRIPTION	2. FAILURE SYMPTOM		3. POSSIBLE CAUSES	4. FAILURE DETECTION METHOD	5. EFFECT OF FAILURE	6. EXISTING COMPENSATING PROVISION	7. CLASS OF FAILURE	8. FAIL PROB	9. REMARKS
	SERIAL NUMBER	DESCRIPTION							
To extend/retract outrigger.	001	Unable to extend or retract outrigger.	Selector valve faulty.	Indirect--no response to control.	Outrigger does not extend or retract.	None	Critical	Very low	
			Control valve faulty.	Indirect--no response to control.	Outrigger does not extend or retract.	None	Critical	Very low	
			Manifold clogged.	Indirect--no response to control.	Outrigger does not extend or retract.	None	Critical	Very low	
		Unable to extend outrigger.	Relief valve continually open.	Indirect--no response to control.	Outrigger does not extend.	None	Critical	Very low	
			Cylinder leaks.	Indirect--no response to control.	Outrigger does not extend.	None	Critical	Very low	
		Outrigger retracts without control.	Loss of hydraulic pressure.	Indirect--bed of truck slants.	Crane and truck could tip over.		Catastrophic	Low	Holding valve should be installed in the outrigger controls.
			Relief valve opens.	Indirect--bed of truck slants.	Crane and truck could tip over.		Catastrophic	Very low	Holding valve should be installed in the outrigger controls.

SYSTEM _____

SUBSYSTEM Power Block

EQUIPMENT Power Block

F M E A

FAILURE MODE AND EFFECT ANALYSIS

SHIP-TO-SHORE CABLE ELEVATION UNIT AND POWER BLOCK

DATE September 1983

1. OUTPUT SPECIFICATION FUNCTIONAL DESCRIPTION	2. FAILURE SYMPTOM		3. POSSIBLE CAUSES	4. FAILURE DETECTION METHOD	5. EFFECT OF FAILURE	6. EXISTING COMPENSATING PROVISION	7. CLASS OF FAILURE	8. FAIL PROB	9. REMARKS
	SERIAL NUMBER	DESCRIPTION							
To operate power block.	001	Unable to operate power block.	Control valve faulty.	Indirect--no response to control.	Power block does not operate.	None.	Critical	Very low	
			Motor and gears inoperative.	Indirect--no response to control.	Power block does not operate.	None.	Critical	Very low	
			Loss of hydraulic pressure.	Indirect--no response to control.	Power block does not operate.	None.	Catastrophic	Low	

3.4 Equipment and Component Failure Rate

To evaluate the design of the crane and power block for reliability, the failure rate (λ) or Mean Time Between Failures (MTBF) = ($1/\lambda$) for all items (i.e., unit, assembly, or component) that comprise the system is needed.

The MTBF or failure rate can be computed or determined in different ways. For equipment that have been in use for some time, actual data can be used to provide the failure rate data. For equipment that is new in design and has not been used extensively in the field, a part stress analysis (i.e., prediction technique) provides the best estimate of failure rates. The part stress analysis is valid when access to the system design parameters are available. Since the design of both the crane and power block has been completed and access to the system design parameters are not readily available, an alternative to the above is recommended. A generic failure rate approach is the technique that will be used for the crane and power block. Appendix B of MIL-HDBK-217C provides the guidance in performing a generic failure rate prediction. MIL-HDBK-217C and RADC TR-75-22 provides basic failure rates for individual components, assemblies, and units that comprise the crane and power block. The items and failure rates are listed in Table 1.

Table 1. Generic Failure Rate Data

	Item	Description	Failure Rate 10^6 hours
1.	Tandem pump	Gear type	28.5
2.	Filter	10 micron	3.9
3.	Strainer	Wire mesh	3.9
4.	Selector valve	2 pos/3-way	24.9
5.	Flow divider valve	Pressure reducer and flow control	9.9
6.	Winch manifold and relief valve	Spring actuated	3.2
7.	Winch control valve (2)	3 pos/4-way	30.0
8.	Motor and gears (winch)	Planetary motor	40.6
9.	Boom control valve (2)	3 pos/4-way	30.0
10.	Swing control valve (2)	3 pos/4-way	30.0
11.	Boom telescoping control valve (2)	3 pos/4-way	30.0
12.	Boom cylinder	Double acting	4.5
13.	Swing motor and gears	Piston type	40.6
14.	Boom cylinder #1	Double acting	4.5
15.	Boom cylinder #2	Double acting	4.5
16.	Boom cylinder #3	Double acting	4.5
17.	Holding valves (cylinder #2 and #3)	Pilot operated	12.6
18.	Outrigger manifold and relief valve	Spring activated	3.2
19.	Main cylinder control valve (2 each)	3 pos/4-way	30.0
20.	Auxiliary cylinder control valve (2 each)	3 pos/4-way	30.0
21.	Holding valves (4)	Pilot operated	25.2
22.	Main cylinder (2)	Double acting	8.6
23.	Auxiliary cylinder (2)	Double acting	8.6
24.	Hydraulic power block (2) valve	3 pos/4-way	30.0
25.	Motor (power block)	Gear type	28.4
26.	Hose/tag line swivel	-	8.4
27.	Dual load bearing swivel	-	8.4
		λTotal =	486.9

The failure rates in Table 1 are failures per 10^6 hours. A more useable value for the crane and power block would be in failures per year. It is estimated that the crane and power block would operate 4 hours a day or 20 hours per week or 1040 hours/year. Converting 486.9 failures/10^6 hours to failures/year resulted in 0.5 failures/year. In addition, the MTBF, another important parameter and measure of reliability is computed in the following manner.

$$MTBF = \frac{1}{\lambda} = \frac{10.6}{486.9} = 2054 \text{ hours} \quad (3)$$

3.5 Maintainability Analysis

The results of performing maintainability engineering analysis on the crane and power block using the guidance from MIL-HDBK-472, will produce a Mean-Time-To-Repair (MTTR) parameter. This quantitative value includes only active repair time. This parameter is widely used as the salient maintainability parameter. Another important parameter is maintenance man-hours per operating hours (MMH/OH). This parameter specifies the hours spent on performing both corrective and preventive maintenance divided by the total operating hours of the item being evaluated. Both MTTR and MMH/OH will be determined as the results of the subsequent analysis.

In order to perform a MTTR prediction, the active repair time and failure rate of each of the components that comprise the crane and power block is required. Only the major components will be included. The active repair time will be estimated using the procedures described below. The failure rates of the components were from Section 3.4.

The prediction assumes ideal support environment and does not include administration and logistics delay times. The prediction will include only those items that can be readily replaced at the maintenance shop. This includes all the valves; fuel filter and strainer; winch, swing, and power block motors; sheave on power block and tandem pump.

MTTR can be expressed mathematically as:

$$MTTR = \frac{R_p(\text{column 12})}{\lambda R_p(\text{column 2})} = \frac{1040.058}{486.9} = 2.14 \text{ hours} \qquad (4)$$

The following maintainability worksheets provide the maintainability prediction of the crane and power block and consists of localizing and isolating faults to the component level, disassembly, interchange, reassembly and retest (i.e., checkout) of components.

The number in parenthesis below refers to the identical column on the worksheets.

(1) Part Name: Refers to the crane or power block component.

(2) Failure Rate: Refers to the failure rates ($\lambda/10^6$ hours) of each component. Determined and directly extracted from Section 3.4.

(3) Localization: Refers to the estimated average time required to locate a failure without accessory test equipment.

(4) Isolation: Refers to the estimated average time required to locate a failure without accessory test equipment. Isolation time commences with setup of the test equipment and terminates when the fault has been isolated to the item being replaced.

(5) Disassembly: Refers to the estimated average time required for equipment assembly, to the extent necessary to gain access to the item being replaced. Disassembly time was estimated directly from MIL-HDBK-472, Procedure II. Work element time worksheets were utilized to record the detailed step-by-step tasks and associated times with disassembly. Item disassembly times have been extracted from these worksheets.

(6) Interchange: Refers to the estimated average time required to remove the defective item and install the replacement. Item interchange times have been extracted from work element time worksheets. These worksheets were utilized to record the detailed step-by-step interchange tasks.

(7) Reassembly: Refers to the estimated average time required to reassemble the equipment after the replacement has been made. Reassembly is normally the reverse of disassembly, resulting in identical time values.

(8) Alignment: Refers to the estimated average time required to perform any alignment, minimum tests and/or adjustment mode necessary by the repair action. Neither the crane or power block requires any alignment.

(9) Checkout: Refers to the estimated average time required to perform minimum checks or tests required to verify that the equipment has been restored to satisfactory performance.

(10) Rp: Refers to the total repair time (columns 3-9) required for performing a single corrective maintenance action in the case of failure.

(11) λRp: Refers to the product of the failure rate (λ) and total repair time. This factor is used to compute MTTR.

SYSTEM _____

SUBSYSTEM Cable Elevation Unit

EQUIPMENT _____

MAINTAINABILITY PREDICTION

PAGE 1 OF 2

DATE September 1983

1. PART NAME	2. FAILURE RATE /10^6 HRS (λ)	MAINTENANCE TASKS TIMES							10. R_p	11. λR_p
		3. LOCALIZATION	4. ISOLATION	5. DISASSEMBLY	6. INTERCHANGE	7. REASSEMBLY	8. ALIGNMENT	9. CHECKOUT		
1. Tandem pump	28.5	0.1667	N/A	N/A	1.5	N/A	N/A	0.3334	2.0001	57.003
2. Filter	3.9	N/A	N/A	0.058	0.0416	0.058	N/A	N/A	0.1576	0.615
3. Strainer	3.9	N/A	N/A	0.058	0.0416	0.058	N/A	N/A	0.1576	0.615
4. Selector valve	24.9	0.1667	N/A	0.116	0.0794	0.116	N/A	0.1667	0.6448	16.056
5. Flow divider valve	9.9	0.1667	N/A	0.116	0.0794	0.116	N/A	0.0833	0.5614	5.558
6. Winch manifold and relief valve	3.2	0.0833	N/A	N/A	0.1588	N/A	0.0833	0.0833	0.4087	1.308
7. Winch control valves (2)	30.0	0.0833	N/A	0.116	0.4764	0.116	N/A	0.0833	0.875	26.25
8. Winch motor and gears	40.6	*	*	*	*	*	*	*	8.0	324.8
9. Boom control valves (2)	30.0	0.0833	N/A	N/A	0.0794	N/A	N/A	0.0833	0.246	7.38
10. Swing control valves (2)	30.0	0.0833	N/A	0.116	0.4764	0.116	N/A	0.0833	0.875	26.25
11. Boom telescoping control valves (2)	30.0	0.0833	N/A	N/A	0.0794	N/A	N/A	0.0833	0.246	7.38
12. Boom cylinder	4.5	*	*	*	*	*	*	*	2.5	11.25
13. Swing motor and gears	40.6	*	*	*	*	*	*	*	8.0	324.8
14. Boom cylinder #1	4.5	*	*	*	*	*	*	*	4.5	20.25
15. Boom cylinder #2	4.5	*	*	*	*	*	*	*	4.5	20.25
16. Boom cylinder #3	4.5	*	*	*	*	*	*	*	4.5	20.25
TOTAL										

SYSTEM _____

SUBSYSTEM Cable Elevation Unit

EQUIPMENT _____

MAINTAINABILITY PREDICTION

PAGE 2 OF 2

DATE September 1983

1. PART NAME	2. FAILURE RATE /10^6 HRS (λ)	MAINTENANCE TASKS TIMES							10. R_p	11. λR_p
		3. LOCALIZATION	4. ISOLATION	5. DISASSEMBLY	6. INTERCHANGE	7. REASSEMBLY	8. ALIGNMENT	9. CHECKOUT		
17. Holding valves (2)	12.6	0.0833	N/A	N/A	0.0794	N/A	0.0833	0.0833	0.3293	4.149
18. Outrigger manifold and relief valve	3.2	0.0833	N/A	0.116	0.4764	0.116	0.0833	0.0833	0.9583	3.067
19. Main cylinder control valves (2)	30.0	0.0833	N/A	0.116	0.4764	0.116	N/A	0.0833	0.875	26.25
20. Auxiliary cylinder control valves (2)	30.0	0.0833	N/A	0.116	0.4764	0.116	N/A	0.0833	0.875	26.25
21. Holding valves (2)	25.2	0.0833	N/A	0.0	0.0794	0.0	0.0833	0.0833	0.3293	8.298
22. Main cylinders (2)	8.6	*	*	*	*	*	*	*	2.5	21.5
23. Auxiliary cylinders (2)	8.6	*	*	*	*	*	*	*	2.5	21.5
24. Hydraulic power block valves (2)	30.0	0.0833	N/A	0.116	0.4764	0.116	N/A	0.0833	0.875	26.25
25. Motor (power block)	28.4	0.0833	N/A	N/A	0.667	N/A	N/A	0.0833	0.8336	23.674
26. Hose tag line swivel	8.4	0.0833	N/A	N/A	0.417	N/A	N/A	0.0833	0.5836	4.902
27. Dual load bearing swivel	8.4	0.1667	N/A	N/A	0.417	N/A	N/A	0.0833	0.5003	4.203
TOTAL	486.9									1040.058

The estimated times were extracted for MIL-HDBK-472, Tables 2-4 and were based on the work factor system. Small actions were accumulated based upon an individual element time. The following provides an example for the computation that was used for disassembly, interchange, and reassembly times. This specific example shows the computation of a disassembly time (i.e. removing an access panel)

Element Discription	Element Time (Hours)	Times Performed	Total Time
1. Remove bolts on access panel	0.0093	6	0.0558
2. Handle washer	0.0018	6	0.0108
3. Remove panel	0.0025	1	0.0025
			0.0691

The time to disassembly (i.e. removes an access panel) is 0.0691 hours or 4.146 minutes. Similar computations were used to compute all disassembly, reassembly, and interchange times. The localization time was estimated to be either 5 or 10 minutes depending upon the component being evaluated. An example would be when an operator would attempt to operate an outrigger control valve. The valve would be pushed and the cylinder and shoe would not move. The operator perhaps would push another control and it would work, therefore, the source of hydraulic power was available, thereby, localizing the failure to the control valve. The estimated time for this particular function is 5 minutes. With properly prepared troubleshooting charts, the 5 and 10 minute estimates are reasonable for this type of equipment. Isolation time which uses external test equipment was determined not applicable (N/A) for this type of equipment.

The alignment and checkout times were estimated based on the complexity of the task. If a relief valve needed replacing, 5 minutes were estimated in

performing the adjustment (i.e., alignment). The checkout time was also estimated as 5 or 10 minutes depending upon the complexity of the item replaced. The checkout of a replaced control would only require the operation of the valve and would easily be performed within 5 minutes.

The repair time of some items such as the winch motor and gears, boom cylinders, and swing motor and gears, were only estimated as a total number. The complexity of the repair and the availability of support equipment to perform the repairs were not totally known. The estimate provides a realistic value for the work anticipated.

Another maintainability parameter worthy of being developed is the maintenance man-hours per operating hours (MMH/OH). MMH includes both preventive and corrective maintenance. The following preventive maintenance man-hours are estimated.

Task	Frequency	Time	1 Year Total
1. Light lubrication overall	W	1 hour	52
2. Detailed lubrication of gear and cylinders	Q	4 hours	12
		TOTAL	64 hours

The corrective maintenance time for 1 repair for 1 year is 2.13 hours. The total hours spent on maintenance is 64.0 plus 2.13 or 66.13 hours. MMH/OH is computed in the following equation.

$$\text{MMH/OH} = \frac{66.13}{1040.058} = 0.064 \qquad (5)$$

This value is extremely low for this type of equipment.

3.6 Test Requirements

In accordance with MIL-STD-781C, a fixed length test plan provides the best estimate of true MTBF and provides the means to determine if the reliability requirements have been met. The predicted MTBF is 2054 hours and is considered an average value and an estimate of the true value. With application of confidence limit or confidence interval, a measure of the closeness of the estimate to the true value is determined. Calculations of confidence limits are based on chi-square distribution.

Assuming that the predicted value, MTBF = 2054 hours, is what is required, this value establishes the lower one-sided MTBF requirements. Using a chi-square distribution, for 90 percent confidence, the equipment must be tested for the following hours with the associated failures.

0 failure - 4724 hours

1 failure - 4724 hours

2 failure - 8011 hours

In Section 3.4, a predicted generic failure rate was established for the crane and power block that predicted 0.5 failures per year of operation. This assumes that crane operates 20 hours per week. In the event that the test times to validate the MTBF are considered excessive, assume that 1 failure per year is acceptable on the crane and power block. This would produce an MTBF = 1040 hours. For 90 percent confidence, the equipment must be tested for the following hours with the associated failures.

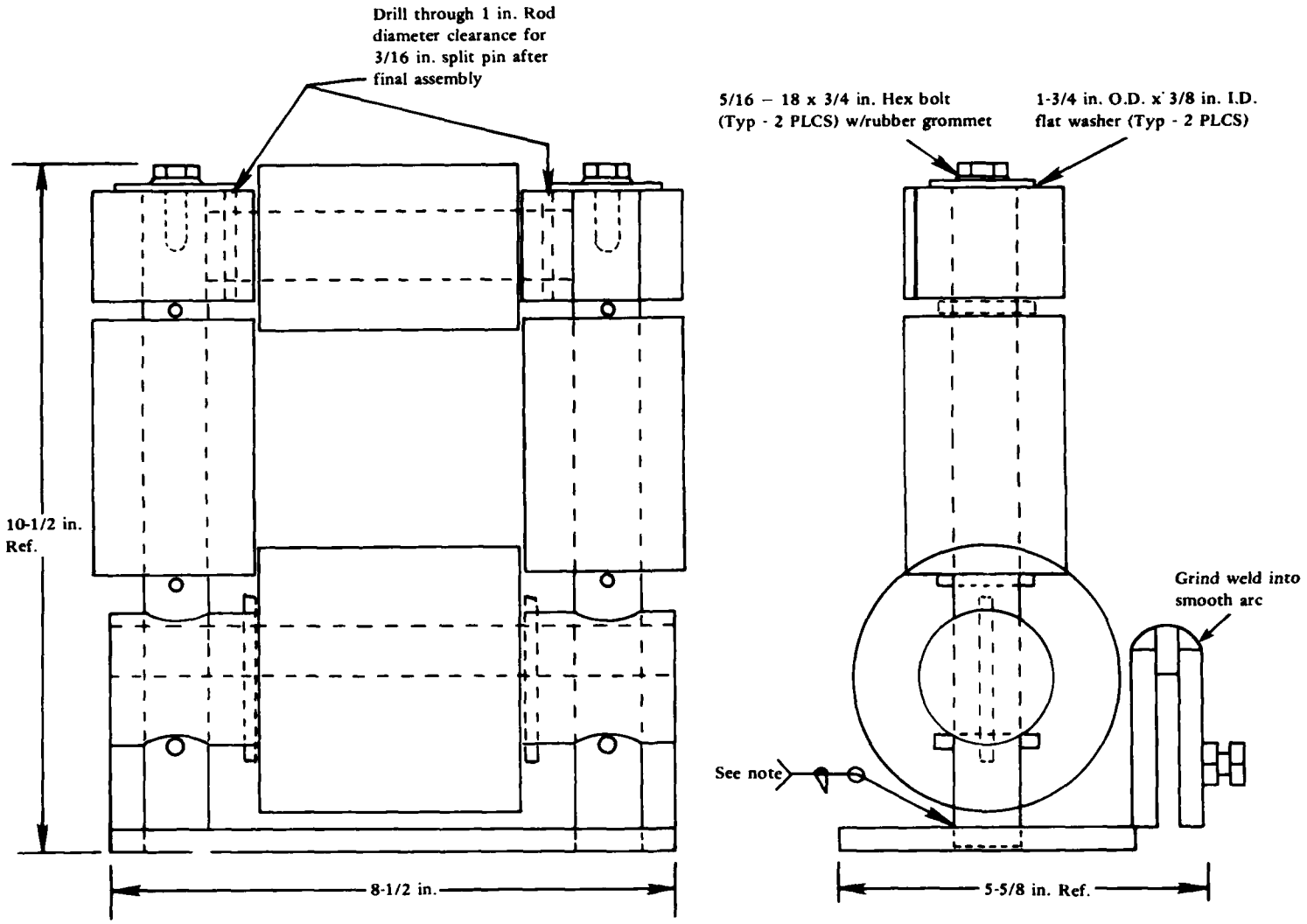
0 failure - 2392 hours

1 failure - 2392 hours

2 failures - 4056 hours

Appendix D

FABRICATION SKETCHES FOR PORTABLE DECK EDGE ROLLERS



PORTABLE DECK EDGE ROLLER ASSEMBLY

NOTE: When welding 1 in. bar to base plate use 2 in. Ø Nylon bar as a spacer near top of 1 in. bars (1 in. bars should be ⊥ to base plate)

Figure D-1.

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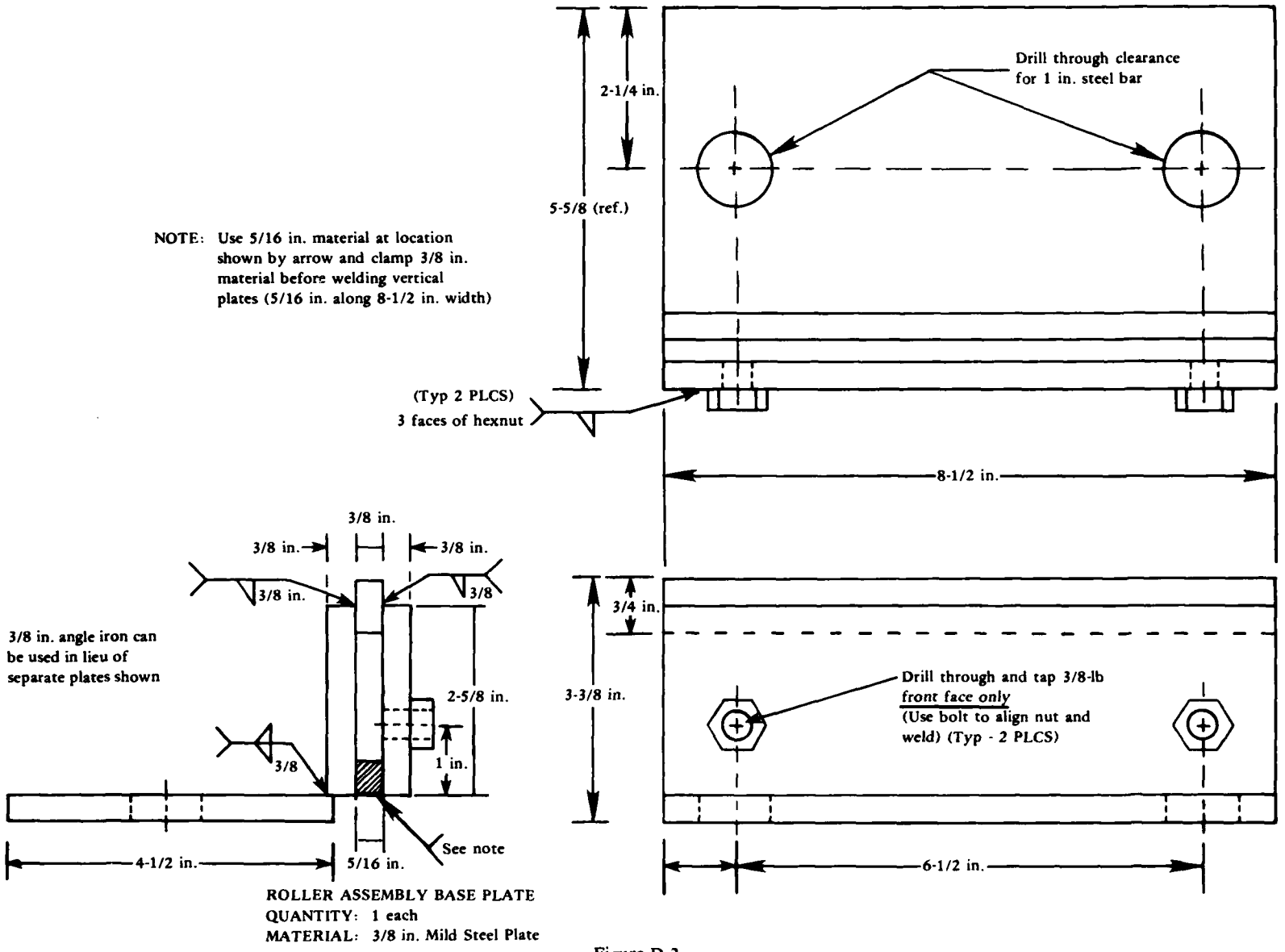
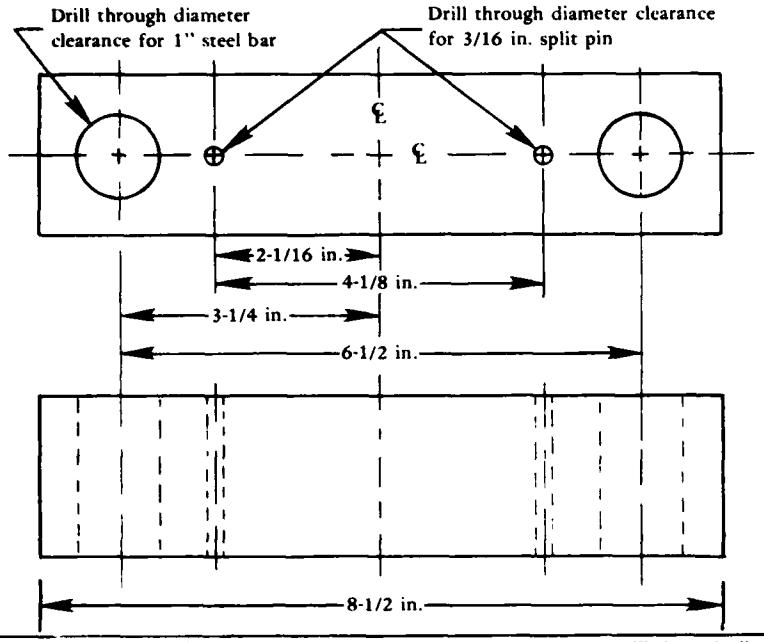
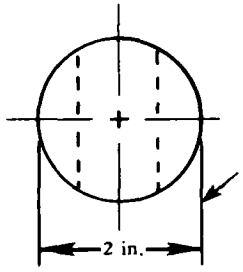


ROLLER ASSEMBLY BASE PLATE
QUANTITY: 1 each
MATERIAL: 3/8 in. Mild Steel Plate

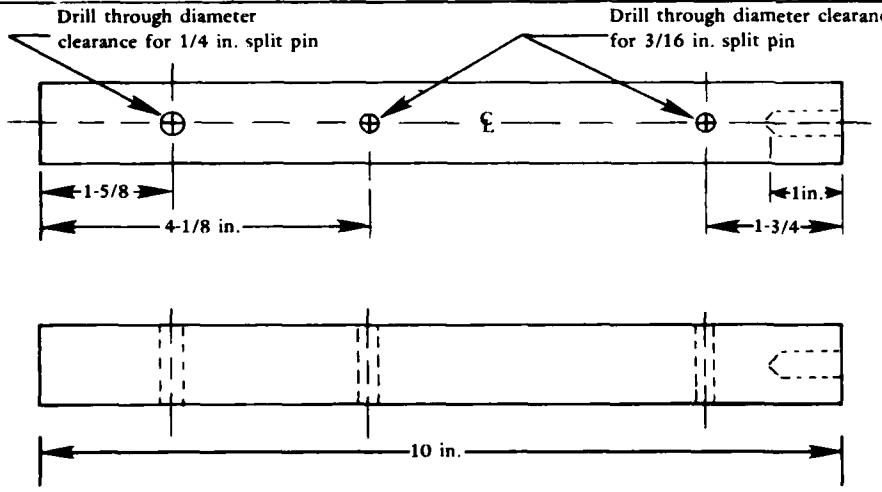
Figure D-2.



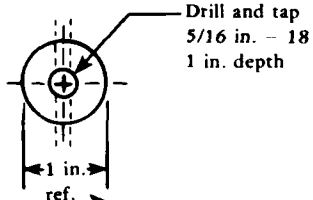
LOWER HORIZONTAL ROLLER SUPPORT
QUANTITY: 1 Each
MATERIAL: 2 in. OD NYLATRON ROD



NOTE: 2 in. NYLATRON Rod machine to fit I.D. of 4 in. NYLATRON tubing with .020 clearance

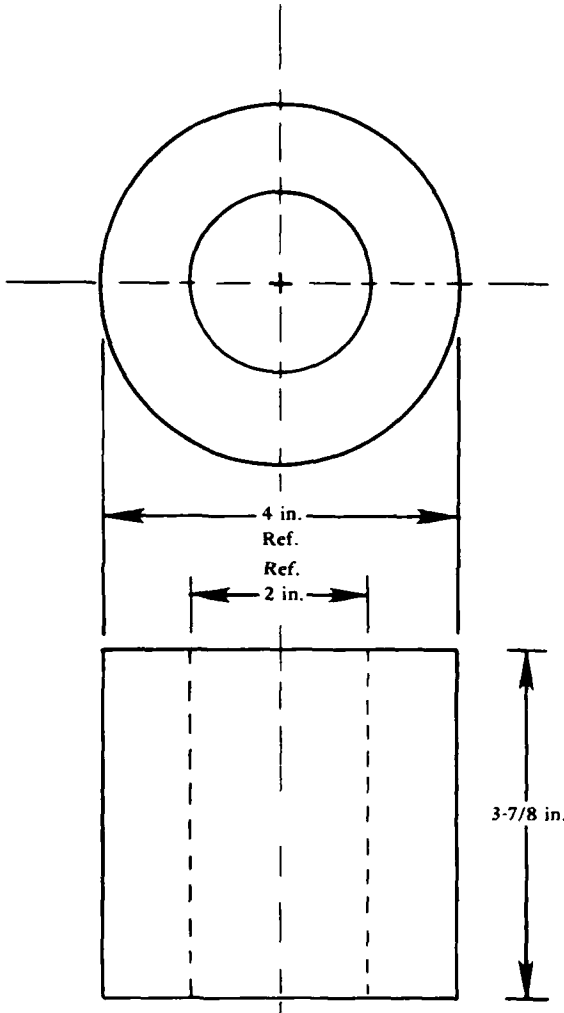


VERTICAL ROLLER SUPPORT
QUANTITY: 2 Each
MATERIAL: 1 in. Diameter Mild Steel Bar

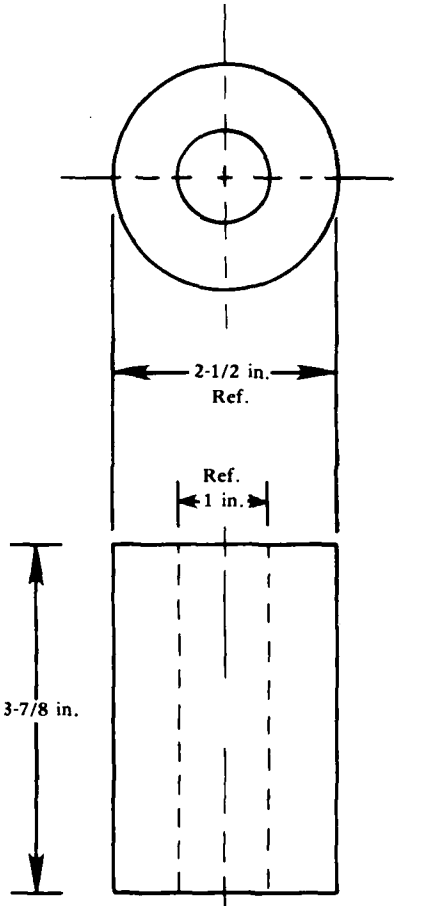


NOTE: 1 in. steel bar machined to fit I.D. of 2-1/2 in. NYLATRON tubing with .020 clearance

Figure D-3.

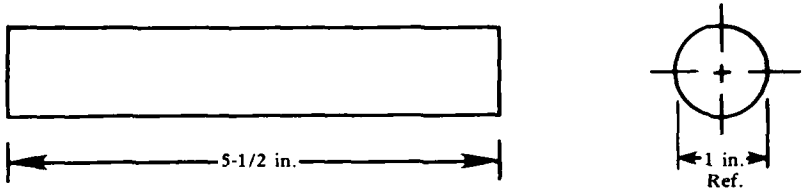


LOWER HORIZONTAL ROLLER
QUANTITY: 1 each
MATERIAL: NYLATRON GS Tubing

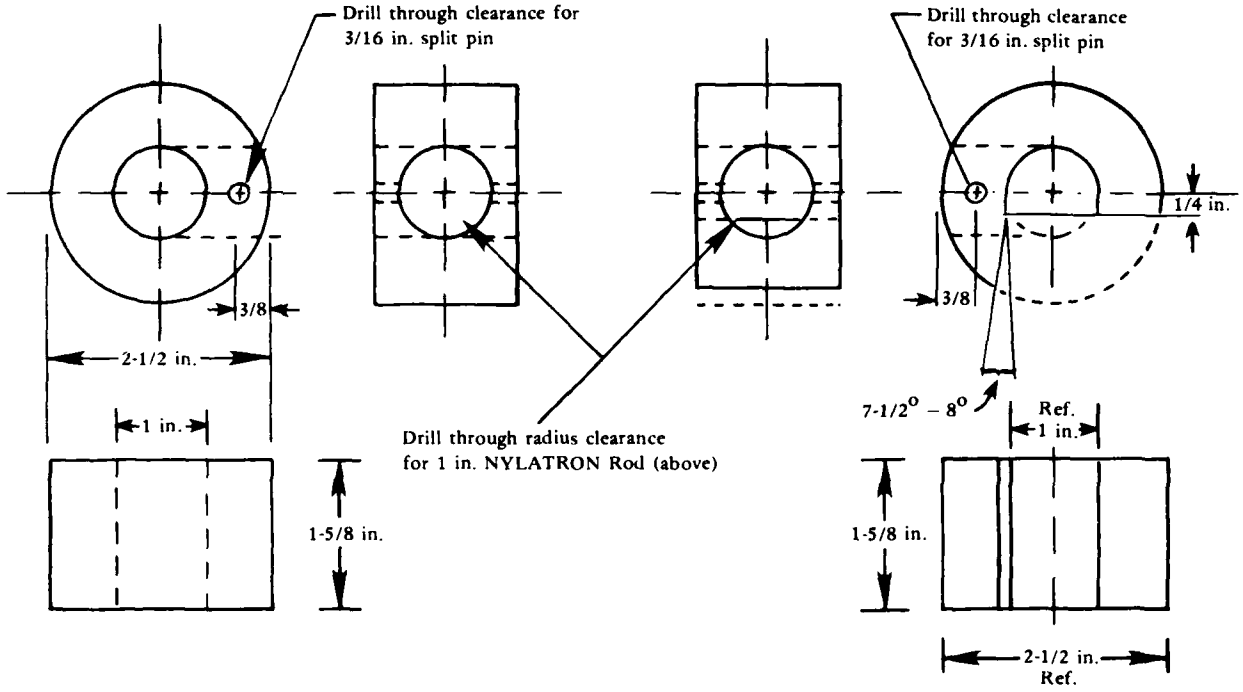


VERTICAL AND UPPER HORIZONTAL ROLLERS
QUANTITY: 3 each
MATERIAL: NYLATRON GS Tubing

Figure D-4.



UPPER HORIZONTAL ROLLER SUPPORT
QUANTITY: 1 each
MATERIAL: 1 in. diameter NYLATRON Rod



UPPER ROLLER SWIVEL BRACKET
QUANTITY: 1 each
MATERIAL: NYLATRON GS Tubing

UPPER ROLLER SWIVEL CATCH
QUANTITY: 1 each
MATERIAL: NYLATRON GS Tubing

Figure D-5.

EJR PLASTICS, INC.

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ORDERED	QUANTITY SHIPPED	BACK ORDERED	ITEM NUMBER	DESCRIPTION	UNIT	UNIT PRICE	AMOUNT
				P O # N62583-84-M-6204		.000	.00
4	4		NMR10	1" NYLATRON ROD	FT	3.360	13.44
6	6			2" DIA NYLATRON GS ROD	FT	11.270	67.62
4	4			2-1/2" OD X 1" ID X 26" LONG GSM NYLATRON TUBE	PC	75.000	300.00
						.000	.00
1	1			4" OD X 2" ID X 26" LONG GSM NYLATRON TUBE	PC	175.000	175.00
						.000	.00
				REQUIRED DELIVERY DATE: 11-29-83.		.000	.00
						.000	.00
				BUYER: BEVERLY		.000	.00
				PHONE: 805-982-5483		.000	.00
				SALES: ROBERT		.000	.00
				WORK ORDER: 04636		.000	.00

No claims allowed unless made within 10 days from date of shipment. Returned goods will not be accepted without seller's written authorization. No claims allowed on cut merchandise. The seller makes no warranty of the fitness of the goods for a specific purpose unless otherwise stipulated herein and/or in our contract. Seller represents that with respect to the production of goods and/or performance of services covered by this invoice it has fully complied with the Fair Labor Standards Act as amended.

NON-TAXABLE	TAXABLE	SALES TAX	FREIGHT	MISCELLANEOUS	INVOICE TOTAL	
556.06	.00	.00	.00	.00		556.06

INVOICE

DEPT OF THE NAVY
06299

INVOICE DATE	INVOICE NO
12/08/83	00012395

Formerly
Precision Plastics

EJR PLASTICS, INC.
4901 Pacific Coast Hwy
San Diego, CA 92110
714-297-7220

PLEASE RETURN THIS PORTION OF THE INVOICE WITH YOUR PAYMENT.

We reserve the right to charge 1½% per month on overdue payments

INVOICE TOTAL
556.06

Figure D-6.

INSTRUCTIONS

The Naval Civil Engineering Laboratory has revised its primary distribution lists. The bottom of the mailing label has several numbers listed. These numbers correspond to numbers assigned to the list of Subject Categories. Numbers on the label corresponding to those on the list indicate the subject category and type of documents you are presently receiving. If you are satisfied, throw this card away (or file it for later reference).

If you want to change what you are presently receiving:

- Delete - mark off number on bottom of label.
- Add – circle number on list.
- Remove my name from all your lists – check box on list.
- Change my address - line out incorrect line and write in correction (ATTACH MAILING LABEL).
- Number of copies should be entered after the title of the subject categories you select.

Fold on line below and drop in the mail.

Note: Numbers on label but not listed on questionnaire are for NCEL use only, please ignore them.

Fold on line and staple.

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PORT HUENEME, CALIFORNIA 93043

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The Naval Civil Engineering Laboratory is revising its primary distribution lists.

SUBJECT CATEGORIES

1 **SHORE FACILITIES**
2 Construction methods and materials (including corrosion control, coatings)
3 Waterfront structures (maintenance/deterioration control)
4 Utilities (including power conditioning)
5 Explosives safety
6 Construction equipment and machinery
7 Fire prevention and control
8 Antenna technology
9 Structural analysis and design (including numerical and computer techniques)
10 Protective construction (including hardened shelters, shock and vibration studies)
11 Soil/rock mechanics
13 BEQ
14 Airfields and pavements
15 **ADVANCED BASE AND AMPHIBIOUS FACILITIES**
16 Base facilities (including shelters, power generation, water supplies)
17 Expedient roads/airfields/bridges
18 Amphibious operations (including breakwaters, wave forces)
19 Over-the-Beach operations (including containerization, materiel transfer, lighterage and cranes)
20 POL storage, transfer and distribution
24 **POLAR ENGINEERING**
24 Same as Advanced Base and Amphibious Facilities, except limited to cold-region environments
28 **ENERGY/POWER GENERATION**
29 Thermal conservation (thermal engineering of buildings, HVAC systems, energy loss measurement, power generation)
30 Controls and electrical conservation (electrical systems, energy monitoring and control systems)
31 Fuel flexibility (liquid fuels, coal utilization, energy from solid waste)
32 Alternate energy source (geothermal power, photovoltaic power systems, solar systems, wind systems, energy storage systems)
33 Site data and systems integration (energy resource data, energy consumption data, integrating energy systems)
34 **ENVIRONMENTAL PROTECTION**
35 Solid waste management
36 Hazardous/toxic materials management
37 Wastewater management and sanitary engineering
38 Oil pollution removal and recovery
39 Air pollution
40 Noise abatement
44 **OCEAN ENGINEERING**
45 Seafloor soils and foundations
46 Seafloor construction systems and operations (including diver and manipulator tools)
47 Undersea structures and materials
48 Anchors and moorings
49 Undersea power systems, electromechanical cables, and connectors
50 Pressure vessel facilities
51 Physical environment (including site surveying)
52 Ocean-based concrete structures
53 Hyperbaric chambers
54 Undersea cable dynamics

TYPES OF DOCUMENTS

85 Techdata Sheets
86 Technical Reports and Technical Notes
82 NCEL Guide & Updates
83 Table of Contents & Index to TDS
91 Physical Security
☐ None—remove my name

PLEASE HELP US PUT THE ZIP IN YOUR MAIL! ADD YOUR FOUR NEW ZIP DIGITS TO YOUR LABEL (OR FACSIMILE), STAPLE INSIDE THIS SELF-MAILER, AND RETURN TO US.

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